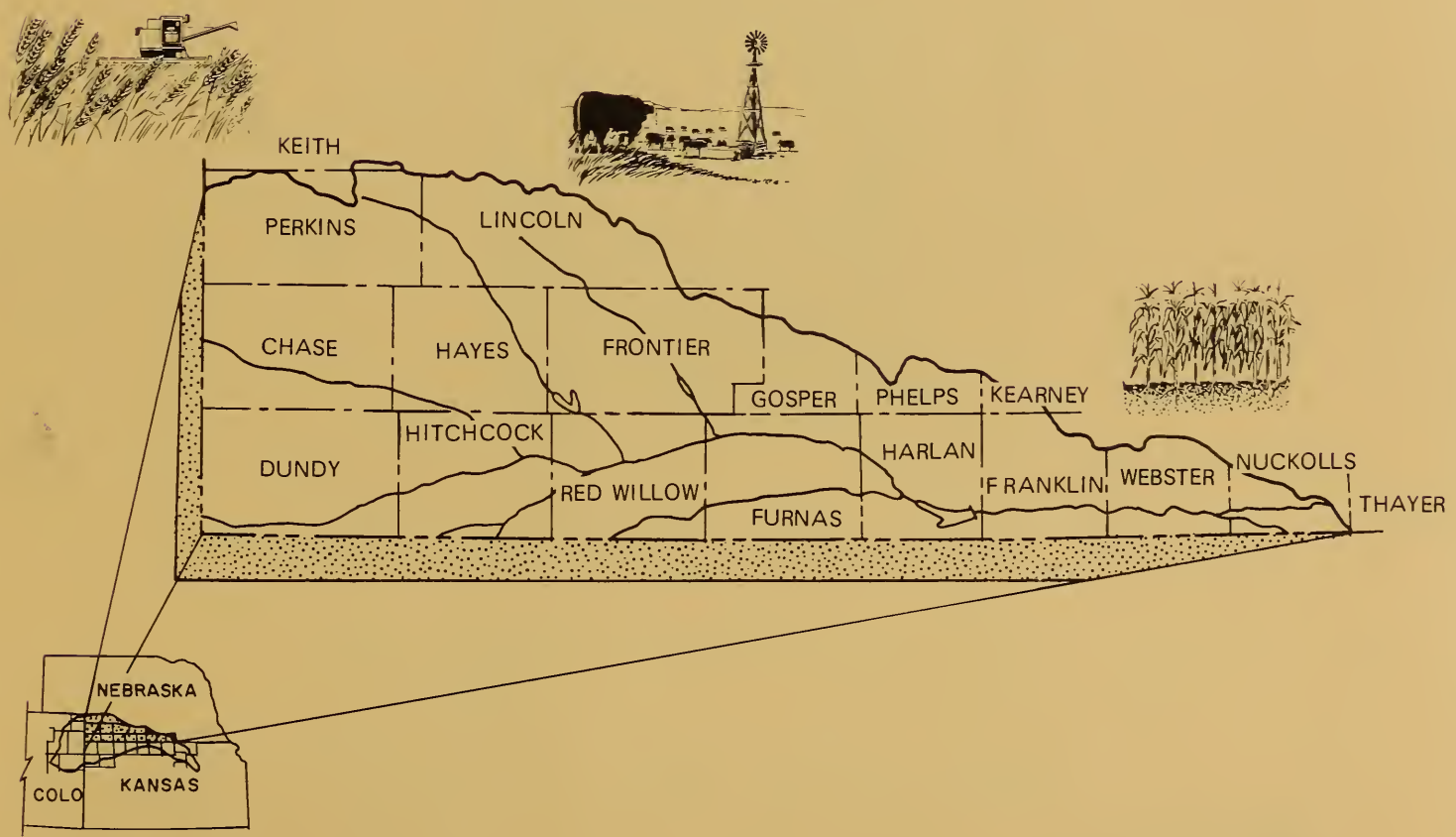
REPUBLICAN RIVER BASIN
Nebraska

WATER AND RELATED LAND RESOURCES

STUDY REPORT



U.S. DEPARTMENT OF AGRICULTURE
Economics, Statistics, and Cooperatives Service
Soil Conservation Service
Forest Service

1978

REPUBLICAN RIVER BASIN

NEBRASKA

WATER AND RELATED LAND RESOURCES

Prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

ECONOMICS, STATISTICS, AND COOPERATIVES SERVICE

FOREST SERVICE

In Cooperation With

UPPER REPUBLICAN NATURAL RESOURCES DISTRICT

MIDDLE REPUBLICAN NATURAL RESOURCES DISTRICT

LOWER REPUBLICAN NATURAL RESOURCES DISTRICT

TRI-BASIN NATURAL RESOURCES DISTRICT

NEBRASKA NATURAL RESOURCES COMMISSION

1978

Perkins, Chase, and Dundy Counties

Upper Republican
Natural Resource District

Headquarters In Imperial
135 W. 5th St.
Phone 308-882-5173

Benny Martin
State Conservationist
Soil Conservation Service
345 Federal Building
Lincoln, Nebraska 68508

Dear Mr. Martin;

This letter is in regard to the draft of the Republican River Basin report, Nebraska Water and Land Resources. This report has been received by the staff and board for this NRD.

Our endorsement is for only the area of study within the Upper Republican Natural Resources District.

It is our opinion that your staff has done an excellant job of compiling useful data and identifying the problem areas. The district will use this information in developing our future plans and programs.

The district understands that any project to be implemented must be re-examined for feasibility.

The board of directors endorses the general outline of the Republican River Basin Study.

Ronald L. Milner

For the Board of Directors
Ronald Milner, Manager
Upper Republican NRD
Imperial, Ne. 69033

RM/dr

Middle Republican Natural Resources District

P.O. BOX 81 CURTIS, NEBRASKA 69025 PHONE (308) 367-4281

July 16, 1979

Mr. Benny Martin
State Conservationist
Soil Conservation Service
345 Federal Building
Lincoln, Nebraska 68508

Dear Mr. Martin,

The drafts of the report for the Republican River Basin, Nebraska Water and Land Resources have been reviewed by staff and board for this NRD. Our endorsement is related only to the area of study within the Middle Republican Natural Resources District.

Your river basin staff has done an excellent job of compiling useful data and identifying problem areas. All of this information will be very helpful to this NRD in developing future plans and programs. It is understood there will be changes in detailed planning before any implementation occurs in which case any project or program would need to be reexamined for feasibility.

On July 16, 1979, the Board of Directors for the Middle Republican Natural Resources District approved a general endorsement of the Republican River Basin Study.

Sincerely,

H. J. Nelson

H.J. Nelson, Chairman
HJN/alt

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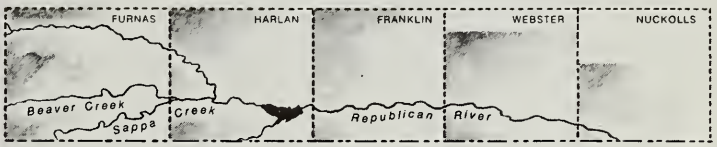

lower republican natural resources district

July 25, 1979

Benny Martin
State Conservationist
Soil Conservation Service
345 Federal Building
Lincoln, Ne. 68508

Dear Mr. Martin:

The Lower Republican Natural Resources District has received the last draft copy of the Republican River Basin, Nebraska Water and Land Resources Plan. This letter should serve as a notice to you of our endorsement of this plan; especially as it relates to the area within our District boundaries.

On July 24, 1979, the Lower Republican NRD Board of Directors approved a general endorsement of this Republican River Basin Study. Our District also wishes to thank your river basin staff for the quality job performed in compiling the data included in this study. The information included in this study will be greatly appreciated by our District in our future plans and programs. Additional, more detailed, planning will need to occur before any project or program is implemented as the result of this plan. However, our District believes this Republican River Basin Plan will help serve as a general guide for this NRD's resource development activities.

Again, our thanks to your staff for their work in developing this useful resources planning tool.

Sincerely,

Paul Schroeder

Paul Schroeder, Chairman
Lower Republican NRD

RW:kks

Tri-Basin NATURAL RESOURCES DISTRICT

1308 SECOND P. O. BOX 528
HOLDREGE, NEBRASKA 68949

TELEPHONE (308) 995-6688

July 24, 1979

Mr. Benny Martin
State Conservationist
Soil Conservation Service
345 Federal Building
Lincoln, Nebraska 68508

Dear Mr. Martin:

On August 1, 1978 this NRD was supplied with a copy of the final review draft of the Republican River Basin, Nebraska Water and Related Land Resources Study. We were given an opportunity to review this draft and it is my understanding through telephone conversation with the Water Resources Planning Staff, SCS, Lincoln, that most of the suggested changes have been incorporated in the current version.

Only a comparatively small portion of the entire Republican River Basin, Nebraska is within this NRD, principally that part of the basin lying in Gosper, Phelps and Kearney Counties. The provisions of the study relating to that area as well as those sections applying to the entire basin without reference to any specific area are compatible with the goals and objectives of this NRD. Much of the information in the report will be helpful in future District planning.

Sincerely,

William G. Umberger
General Manager

WGU/hc

PROGRAMS:
SOIL & WATER CONSERVATION
WATERSHED PROTECTION
COMPREHENSIVE PLANNING
FLOOD PLAIN MANAGEMENT
DATA BANK
WATER QUALITY PLANNING
DEVELOPMENT FUND

STATE OF NEBRASKA

NATURAL RESOURCES COMMISSION

P. O. Box 94876
Lincoln, Nebraska 68509

Office Location:
Fourth Floor
301 Centennial Mall South

June 25, 1979

Mr. Benny Martin
State Conservationist
Soil Conservation Service
345 Federal Building
Lincoln, Nebraska 68508

Dear Benny:

The Natural Resources Commission was pleased to have the opportunity to serve as the coordinator of the state review of the report on the Republican River Basin, Nebraska Water and Related Land Resources and cooperate in its development. This report provides a thorough inventory of the basin's resources and problems, and a useful display of the alternative plans and USDA capabilities.

At its meeting on June 21, 1979, the Natural Resources Commission endorsed the report on the Republican River Basin and the recommended plan. The Commission will do whatever it can to assist the Natural Resources Districts in implementing the plan.

Sincerely,

Dayle E. Williamson
Executive Secretary

DEW:JW:cd

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All photographs used in this report are from Soil Conservation Service unless otherwise noted.

CHAPTER I
SUMMARY

Purpose

The purpose of the Republican River Basin Cooperative Study is to identify the water and land related problems and possible solutions within the authority assigned to the United States Department of Agriculture (USDA). This study area is the portion of the Republican River Basin in Nebraska and hereafter referred to as the basin.

Data developed in the course of this study will also be used by the Nebraska Natural Resources Commission (NNRC) in the development of the Nebraska Water Planning and Review Process. The four Natural Resources Districts (NRD) in which almost all the basin lies are the Upper Republican, Middle Republican, Lower Republican, and the Tri-Basin. These NRD's will use the results of this study as guidelines in developing their respective plans of work.

The USDA will use this information as a basis for assisting State and local organizations in the development, conservation and preservation of the basin resources under the provisions of the Watershed Protection and Flood Prevention Act as well as other USDA programs. It will also be directly useful to other programs and studies concerned with the basin land and water resources. Among these are the programs concerned with non-point pollution as this study identifies the severity and general location of lands with excessive rates of erosion. This study identifies the types and amount of conservation land treatment and management and the effect they will have on runoff waters from small watersheds. This data will be useful in studies concerned with surface water yields.

Authority

The USDA participated in this study under the authority of Section 6 of the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 566, as amended).

Description of the Basin

The Republican River drainage area consists of 25,018 square miles in northeastern Colorado, southwestern Nebraska and northwestern Kansas. This study area is concerned with the 9,712 square miles in Nebraska or 39 percent of the entire Republican River drainage area. The Nebraska portion is triangular shaped with an east-west length of 230 miles and a maximum north-south distance of 70 miles. The elevation in Nebraska ranges from about 3,300 feet in the western section to about 1,500 feet at the point where the Republican River leaves Nebraska and enters Kansas. Land and water areas in Nebraska amount to 6,215,500 acres (Table I-1).

TABLE I-1 LAND AND WATER AREAS
Republican River Basin, Nebraska

Area	Acres
Cropland	3,060,100
Nonirrigated	2,482,000
Irrigated	578,100
Pasture and Range	2,822,000
Forest and Woodland	40,000
Other Agriculture Land	97,800
Total Agricultural Land	6,019,900
Urban and Built-up	149,200
Water Areas	46,400
Over 40	23,800
Under 40	22,600
Total Basin	6,215,500

The weather varies from sub-humid to a semi-arid continental climate. The variability of the weather in the basin is typical of that occurring in the interior of a large land mass in the temperate zone. Rapid weather changes are caused by invasion of large masses of warm, moist air from the Gulf of Mexico, hot, dry air from the southwest, cool, dry air from the Pacific Ocean, and cool, dry air from Canada. Average precipitation decreases uniformly from about 28 inches in the eastern part to 18 inches in the western part of the basin.

Agriculture, including a limited amount of processing of agricultural products, is the most important sector of the economy. About 39.9 percent of the basin is nonirrigated cropland, 9.3 percent irrigated cropland, 45.4 percent pasture and range, and 2.2 percent other agricultural uses. Nonagricultural uses such as urban areas, industrial tracts, transportation areas, and water occupy 3.2 percent of the total expanse.

Corn, wheat and grain sorghum are the major crops grown when measured in value of production. Nearly all of the wheat is produced under nonirrigated conditions, whereas, most of the corn is grown on irrigated land. Cattle and hogs are the major types of livestock produced. Cow-calf herds are common in the ranching areas. Cattle numbers have increased in recent years due to the expanded production of feed grains and roughage on irrigated land.

Currently, there are 578,100 acres of cropland irrigated. By 2000, irrigation is projected to increase to 887,600 acres, and by 2020, it will expand to 967,600 acres. The acres of cropland are not expected to change, therefore, the added irrigation will come from nonirrigated cropland. The remaining land uses are not expected to change significantly.

Total population of the basin in 1975 was 66,837 or about 4.3 percent of the State total. This is a decline of 23 percent since 1950. Most of the decline is due to outmigration of the rural farm population.

Unemployment rates are very low, however, the problem of underemployment persists. Per capita income for the basin currently compares favorably with the national measure. However, prior to 1971, per capita income for the United States exceeded the basin's by more than 10 percent.

The export of farm products is very important to the local economy. In 1974, exports accounted for 46 percent of the earnings for all industries in the basin.

Problems and Objectives

Erosion is a serious problem on some classes of land in the basin and amounts to 30.5 million tons annually. The average sheet and rill soil loss from cropland is about 7 tons per acre and accounts for two-thirds of all of the soil loss. However, three-fourths of this amount occurs on 892 thousand acres of cropland which is less than one-third of the cropland. About one-half of the excessive soil loss is from 214 thousand acres of Class VI and VII lands that are cultivated.

Sediment deliveries from the watersheds in the basin to the mainstem of the Republican River and major tributaries average 6 million tons annually. Over 50 percent comes from sheet and rill erosion, and the balance is divided among gully, 1.1 million tons, streambank erosion, 1.3 million tons and bedload, 511 thousand tons. These sediment loads, while well within estimated accumulations, fill reservoirs and stream channels. The total cross-sectional area in the mainstem below Harlan County Reservoir has been decreased by 5 percent over the past 26 years.

The average annual nutrient loads delivered by sediment from agricultural lands to water courses are estimated to be 4,360 tons of nitrogen and 323 tons of phosphorus. This represents a significant loss of plant nutrients from the farms in the basin and decreases farm income. These same nutrients which represent a loss to farmers contribute to nutrient pollution of lakes, streams and ground water.

Consumptive water use in the basin for selected purposes amounts to 915 thousand acre feet annually. It is expected that this will increase by 844 thousand acre feet by year 2000 to a total of 1.76 million acre feet. Of this amount, 90 percent or 1.6 million acre feet will be consumptively used by irrigated crops in the basin. The effects of this

increase in irrigation, which will come almost entirely from ground water, will decrease base flows of streams in the basin. Irrigation storage reservoirs such as Enders, which are supplied principally by base flows, have had a gradual decline in the amount of water available. The other reservoirs in the basin which depend more on surface flows than base flows are affected a lesser degree. The projected improvement by year 2000 on farm efficiency from 55 to 75 percent for gravity system and from 65 to 75 percent for pivot systems will save water, reduce energy costs and reduce vector problems.

Flooding of crops, pastures and rural property is a major problem in the watersheds of the basin. Although damages in some watersheds are high and rates per acre compare to other parts of the State, most remaining watersheds have either a low damageable value or a low percentage of flood plain area. The 117 thousand acres of flood plain in these watersheds are expected to sustain annual damages of nearly 3.0 million dollars by year 2000. Two watersheds with flooding problems appear to have feasible solutions.

Water based recreation opportunities were evaluated, and projections indicate that adequate facilities will be available at year 2000.

Fish and wildlife problems were determined on the basis of the demand and supply of habitat and harvestable species. Hunting demand for Bobwhite Quail and Ring-Necked Pheasants will exceed supply by the year 2000. Recent declines in wildlife population numbers are attributed to the losses of habitat and habitat quality. Fishing resources are presently adequate to meet demand, however, fishing in reservoirs has declined in recent years due to high rough-fish populations, high turbidities and untimely reservoir drawdowns for irrigation purposes. Fishing can be improved on several streams with mechanical and vegetative practices. Stream fishery improvement coupled with increased fisherman access will enhance the use of this resource.

Environmental objectives are those relative to enhancement of environmental quality by the management, conservation, preservation, creation, restoration or improvement of the quality of certain natural resources and ecological systems. Objectives previously addressed, were identified and quantified to include the interrelationships of environmental factors--improvement of water quality; reduced gully, streambank and roadside erosion; reduced sediment damage and the preservation, creation and restoration of fish and wildlife habitat.

There appears to be no cause for concern for the 2.8 million acres of prime farmland in the basin. Changes in population in the basin are not expected to have any significant impact on prime farmland. Similarly, industrial growth is not expected to impact any substantial acreage of prime farmland. However, small acreages on the periphery of urban areas may be connected to nonagricultural uses as they are added to present installations and nonagricultural land uses.

More intensive cropping of the land and the introduction of pivot irrigation systems have resulted in removal of windbreaks and riparian habitat along stream courses accounting for a decrease of forest and woodland. Forest and woodland have declined from 53,000 acres in 1967 to 40,000 currently and are expected to decline another one-thousand acres to 39,000 by year 2000. Although professional opinion varies, the area of land in wooded areas appears to have stabilized.

Needs and Opportunities

Needs and opportunities were identified for the major objectives. Solutions may be limited by the existing legal structures. Needs for specific components are summarized in Tables I-2, I-3 and I-4.

TABLE I-2 NATIONAL ECONOMIC DEVELOPMENT NEEDS - YEAR 2000
Republican River Basin, Nebraska

Component	Unit	Need or Opportunity
Flood Damage and Sediment Reduction	1976 Dollars	2,955,800
Irrigation - Medium Projection	Acres	309,532
Higher Projection	Acres	464,332
Lower Projection	Acres	154,732
Livestock Water	Acre Feet	2,900
Outdoor Recreation		
Hunting Days		
Pheasants	Hunter Days	85,689
Quail	Hunter Days	1,321
Camping 1/	Recreation Visits	138,201
Picnicking 1/	Recreation Visits	14,245

1/ Additional camping and picnicking facilities are currently being installed at the Harlan County Lake by the Corps of Engineers. The Nebraska Game and Parks Commission is installing additional facilities at the Swanson Reservoir, Medicine Creek Reservoir and the Red Willow Reservoir. These installations will meet the year 2000 recreation visit demand.

TABLE I-3 ENVIRONMENTAL QUALITY NEEDS - YEAR 2000
Republican River Basin, Nebraska

Component	Unit	Need or Opportunity
Roadside Erosion Control	Miles	150
Upland Wildlife Habitat Improvement		
Critical Areas Treated	Acres	13,897
Canyon-Shrub Habitat Protected	Acres	44,925
Center Pivot Corners	Acres	12,164
Other Habitat	Acres	77,045
Stream Fisheries Improvement		
Warm-Water Fisheries	Miles	60
Cold-Water Fisheries		
Fencing & Streambank Protection	Miles	20
In-Stream Mechanical Practices	Miles	20
Accelerated Land Protection 1/	Acres	54,200
Floodwater and Sediment Control Structures	Each	4
Impoundment Removal	Each	1
Wetlands Protection and Improvement		
Private Land Leases	Acres	1,302
Riparian Habitat Protection	Acres	36,700
Irrigation Reuse Pits Seeding	Acres	510
Conservation Treatment and Protection Needs		
Needs Treatment	Acres	2,169,300
Needs Protection	Acres	583,700
Class III Cropland	Acres	229,800
Class IV Cropland	Acres	151,700
Class VI Cropland	Acres	102,000
Class VII Cropland	Acres	1,100
Class VII Pasture & Rangeland	Acres	99,100
Sheet Erosion, Gross	Tons	19,780,000
Sheet Erosion, Delivered	Tons	1,998,000
Gully, Bank and Bedload, Delivered	Tons	2,325,000
Water Quality Improvement		
Sediment	Tons	4,323,000
Nitrogen	Tons	3,139
Phosphorus	Tons	233

1/ This accelerated land protection item is included in the Conservation Treatment and Protection Needs items.

TABLE I-4 COMPARISON OF OBERS PROJECTIONS AND FUTURE WITHOUT PLAN SITUATION - YEAR 2000
Republican River Basin, Nebraska

Commodity	Unit	OBERS E' Projections	Production Based Upon Current Trends	Deficit or (Surplus)
		Thousands		
Wheat	bu.	36,749.8	31,305.8	5,444.0
Rye	bu.	496.2	223.4	272.8
Corn, grain	bu.	89,338.2	112,210.2	(22,872.0)
Silage	ton	753.0	1,695.2	(942.2)
Grain Sorghum	bu.	26,917.6	18,987.7	7,929.9
Oats	bu.	191.1	484.2	(293.1)
Barley	bu.	7.9	71.6	(63.7)
Hay	ton	810.4	765.9	44.5
Soybeans	bu.	181.2	153.9	27.3
Sugarbeets	ton	148.3	246.5	(98.2)
Dry Bean	cwt	100.7	223.3	(122.6)

Plan Elements, Effects and Program Opportunities

Major plan elements, effects and program opportunities are summarized in Table I-5. Data are presented for the entire basin and effects displayed for the Economic Development, Environmental Quality and Social Well-Being Accounts.

Plan elements proposed for installation by year 2000 are estimated to cost $68,702,920. Land treatment elements total $30,913,000 by year 2000.

Economic benefits were determined only for reduced flooding and increased hunting opportunities. Beneficial effects resulting from other plan elements were not evaluated in monetary terms.

TABLE I-5 SUMMARY DISPLAY OF ELEMENTS, EFFECTS AND PROGRAM OPPORTUNITIES
Republican River Basin, Nebraska

Element	Economic Development Account: Beneficial Effects (Dollars)	Economic Development Account: Adverse Effects (Dollars)	Environmental Quality Account: Beneficial & Adverse Effects	Social Well-Being Account: Beneficial & Adverse Effects
Reduce flood damages	66,000 1/	54,280 1/	1. Reduce erosion to less than tolerable limits.	1. Provide potential employment during construction period.
Increase hunting opportunities for quail and pheasants (43,200 hunter-days)	129,600 1/	2/	2. Improve water quality in streams and reservoirs by reducing sediment delivery.	2. Enhance visual quality of agricultural landscape.
Install land treatment (467,000 acres)	3/	30,913,000 4/	3. Decrease agricultural nutrient contributions to streams and reservoirs.	3. Increase population of fish and wildlife for added human enjoyment.
Improve stream fishery (80 miles)	3/	140,400 4/	4. Increase sedimentation during short term installation of structural measures.	4. Improve production of non-game wildlife species used for recreation.
Create & improve wildlife habitat (148,000 acres)	3/	34,392,400 4/ (1,261,600) 5/	5. Change visual quality of landscape with installation of land treatment measures and habitat plantings.	5. Decrease landowner control of leased areas.
Reduce roadside erosion (150 miles)	3/	270,000 4/	6. Improve conditions for waterfowl and other wildlife by preserving wetlands.	6. Continue and enhance production of insect pests on 1,300 acres of wetland.
Protect wetlands (1,300 acres)	3/	490,100 4/	7. Improve quality of aquatic ecosystems.	
Protect riparian woodlands (6,700 acres)	3/	1,675,000 4/ (48,240) 5/	8. Improve wildlife habitat in riparian woodlands.	
Improve irrigation reuse pits for wildlife (510 acres)	3/	103,000 4/	9. Enhance wildlife habitat in critical source areas in basin.	
			10. Disturb wildlife populations during construction.	

Program Opportunities

USDA	Other
1. ACP	1. Natural Resources Districts
2. PL-46	2. State Forestry Program
3. PL-566 Watershed Projects	3. State Game & Parks Commission
4. USFS	4. Environmental Protection Agency
5. FHA Loans	5. Land and Water Conservation Fund
6. USDA - Waterbank	
7. SCS Great Plains Program	

1/ Average annual cost and benefits.
2/ Costs not determined.
3/ Benefits not evaluated in monetary terms.
4/ Total installation cost.
5/ The costs shown in parenthesis are the average annual loss in grazing and/or crop production which would result from the installation of the particular plan elements. These are separate from and in addition to the total installation costs for the particular plan elements.

CHAPTER II
INTRODUCTION

The Nebraska Natural Resources Commission (NNRC), acting upon a request from a local organization known as the Republican Valley Conservation Association, requested the Nebraska Field Advisory Committee, U.S. Department of Agriculture (USDA) to conduct a study of water and related land resources. The study was to identify water and related land resources and to identify possible solutions within the authority of the programs assigned to the USDA. This study concerns only the portion of the Republican River Basin which is located in Nebraska and hereafter is referred to as the basin.

The Nebraska Association of Resources Districts (NARD) approved and adopted a resolution of support for the Republican River Basin Cooperative Study at the Association Convention in Norfolk, Nebraska, on September 10, 1974. This resolution encouraged the local Natural Resources Districts (NRD) to support and participate in the development of the USDA-Republican River Basin Cooperative Study.

Several State and Federal agencies, including the NNRC, Bureau of Reclamation, Corps of Engineers, U.S. Geological Survey, Conservation and Survey Division of the University of Nebraska, Extension Service of the University of Nebraska, Nebraska Department of Water Resources, Nebraska Game and Parks Commission, and Nebraska Department of Health have water and related land resource studies completed, underway or are contemplating studies in the basin. The NNRC expects to use the data and plans of these agencies that are concerned with water and land resource development, as well as the data in this report, in its State Water Planning and Review Process.

Almost all of the study area in the basin lies within four NRDs, which are legal entities of government of the State of Nebraska. These are the Upper Republican, Middle Republican, Lower Republican, and the Tri-Basin NRDs. These districts expect to use the results of this study as general guidelines in developing their respective plans of work.

Authority

Authority for USDA participation in this study is the Watershed Protection and Flood Prevention Act of the 83rd Congress (Public Law 83-566, as amended). The Secretary of Agriculture is authorized to cooperate with other Federal, State and local agencies in the investigation of watersheds, rivers and other waterways to identify potential water resource developments and coordinated programs. The Administrator of the Soil Conservation Service (SCS) advised the State of Nebraska and the Nebraska USDA Field Advisory Committee to proceed with the preparation of a Plan of Work that would be mutually satisfactory to the USDA, State and local sponsors.

Location and Size

The Republican River Basin consists of about 25,018 square miles of eastern Colorado, southern Nebraska and northern Kansas. About 9,712 square miles or 39 percent of the basin is in Nebraska; about 7,745 square miles or 31 percent is in Colorado; and about 7,561 square miles or 30 percent is in Kansas. The Republican River Basin is irregular in shape, being quite wide in the upper reaches, then narrowing in the middle section from where it maintains a comparatively narrow width to the river's mouth near Junction City, Kansas. It is the largest tributary of the Kansas River (Plate 1).

Soils of the basin have developed from loess, alluvium, sand, silt, sandstone, and siltstone parent materials. Permeability rates generally range from high to moderate in the west to moderate in the east.

The area has a variable climate typical of the Great Plains Region. Southwestern Nebraska is in a transition zone between subhumid and semi-arid climates, characterized by extreme daily and seasonal ranges of precipitation and temperature. The normal annual precipitation ranges from 28 inches in the southeastern corner of the basin to about 18 inches in the far western portion. The mean annual temperature is approximately 52°F, and the mean frost-free period ranges from approximately 165 days in the southeastern corner of the basin to 145 days in the northwestern part.

Existing major water resource projects in the study area include the Bureau of Reclamation's Trenton Dam and Swanson Lake, Red Willow Dam and Hugh Butler Lake, Medicine Creek Dam and Harry Strunk Lake, and Enders Dam and reservoir. The Corps of Engineers' Harlan County Reservoir is the largest water impoundment in the basin with an original storage capacity of 850,000 acre feet.

Study Objectives

The objectives of this study were to identify and investigate the scope and intensity of problems specified by the sponsor and identify opportunities and to determine possible solutions to these problems or opportunities. The objectives included the determination of needs and potentials of water and related land resources within the designated authorities of the USDA for the following:

1. Status of land use and treatment.

2. Extent of soil losses and sources of sediment yield.

3. Extent of floodwater damages in delineated watersheds and determination of the potential for alleviation of these damages.

U. S. DEPARTMENT OF AGRICULTURE

GENERAL REFERENCE MAP

REPUBLICAN RIVER BASIN

COLORADO, KANSAS, AND NEBRASKA

SCALE 1/1,250,000

0 5 10 15 20 25 30 MILES

0 5 10 15 20 25 30 35 40 45 KILOMETERS

PLATE 1

4. Extent of agricultural non-point pollution and possible remedial measures.

5. Extent of excess water on agricultural lands.

6. Need for fish and wildlife habitat improvement.

7. Recreation needs.

8. Extent of needs for water supplies or waste disposal in municipal, industrial and rural domestic areas.

9. Effect of land treatment on surface water supplies for irrigation.

Task Force Committees

Seven task force committees were appointed to accomplish the study objectives. The task forces were comprised of specialists from several agencies and members of the Republican River Inter-Basin Council. Task forces were charged with the responsibility of investigating problems and needs within their assigned areas and reporting to the Plan Formulation Task Force.

A brief description of the general assignments and the agencies that provided representatives for each of the task forces are listed below:

Economics and Land Use Task Force

Data were developed for the current situation and for the projection of population, employment, crop yields and production, income, and land use. These projections were used by other task forces to determine requirements for the conservation, utilization and management of water and related land resources. This task force obtained and analyzed data regarding existing land use, future demands for land and the effects of resource development plans upon the land. Mineral resources data were obtained and analyzed. Membership was provided by representatives of the Economics, Statistics, and Cooperatives Service (ESCS), Soil Conservation Service (SCS), U.S. Forest Service (FS), and the NRDs.

Hydraulic and Hydrology Task Force

Stream data were inventoried for use in analyzing flooding, water supply, recreation, and related fish and wildlife resources. The hydrologic effects of project proposals were evaluated, and these results were furnished to other study participants. Personnel of the SCS and the NRDs comprised the membership of this task force.

Fish and Wildlife and Recreation Task Force

Fish and wildlife and recreation resources were inventoried, and studies were conducted to determine the present and estimated future utilization of these resources. Estimates were prepared on future demands, and the effects of land and water resource development plans considered in this study were analyzed. Proposed land and water resource projects were studied with a view of determining their effects upon the environmental and recreational values in the basin. Environmental, historical, archaeological, and natural sites were inventoried and listed with associated needs and potentials for their preservation, protection and enhancement. Membership of this task force consisted of representatives of the Nebraska Game and Parks Commission, SCS, FS, and the Lower Republican NRD.

Flood Damage and Drainage Task Force

Flood plain areas were delineated, and damageable values were determined. Current and projected average annual flood damages for each watershed were established. Alternative plans and programs for flood damage reduction and drainage improvement were studied. Membership of this task force included SCS and FS personnel and a representative of the Middle Republican NRD.

Conservation, Soil Loss, Sediment, and Non-Point Pollution Task Force

Studies dealing with problems associated with sheet, rill, gully, and streambank erosion were made. Estimates were determined for the amounts of soil loss originating in each of these sources and the amount of these losses that became sediment yields. An estimate of sediment delivery was made for each watershed and at various points on the mainstem of the Republican River. The amount of nitrogen and phosphorous carried by the sediments was calculated. Possible solutions to reducing sediment deliveries were suggested by the task force. Representatives of the Lower Republican NRD and the SCS were members of this task force.

Municipal, Industrial and Rural Domestic Water Task Force

Present and future demands of municipal, industrial and rural domestic water uses were determined. The capability of existing sources of supply and facilities to meet the present and future demands of these uses was assessed. Estimates of the facilities and supplies needed to meet future demands were made. A similar examination was made of waste disposal system demands, present and future, and facility ability to meet present and future needs. Representatives of the NRDs and the SCS were members of this task force. The Farmers Home Administration (FmHA), although not a member of the task force, supplied much of the data for this task force.

Plan Formulation Task Force

The USDA plan for the management of water and related land resources that will be a part of the coordinated, comprehensive plan for the basin was formulated. The multi-objective approach was used in evaluating alternatives. Proposals or programs which will satisfy needs and provide solutions for the intermediate (10-15 years) were identified and evaluated. A site inventory was correlated with problems and needs. Potential sites were studied in the field and through the use of aerial photography and U.S. Geological Survey 7½ minute quadrangle maps. Plan formulation included consideration of nonstructural measures. Membership of this task force included representatives of the Upper, Middle, Lower, and Tri-Basin NRDs, FS, SCS, ESCS, Nebraska Game and Parks Commission, and the NNRC.

Nature of the Study

This study is primarily one of reconnaissance level. Information and data from P.L.-566 watershed work plans, both in and out of the basin, were used to the maximum extent possible. The USDA 1967 Conservation Needs Inventory (CNI) report for Nebraska was updated and provided the basis for determining land treatment needs, land use and yield relationships. The ESCS used the updated data in projecting agricultural production and land use. They also collected and analyzed data from other sources regarding population, income and employment. Information and data from studies of other agencies and from various State, Federal and local sources were also used.

The basin had been previously delineated into 64 watersheds used in the 1967 Watershed Needs Inventory. These delineations were adjusted where needed to generally conform to watershed work plan boundaries. As data were lacking for some situations, it was, therefore, necessary to study six watersheds in some depth. These included Beaver, Driftwood, Coon, Turkey, and Milrose Creeks and the Benkleman area. In addition, the Wauneta Flood Project was studied by the planning staff of the NNRC.

Specific projects and programs studied in this report were analyzed only to the point of determining whether economic feasibility and environmental acceptability were indicated. The study focus was on needs for the 15 to 20 year period. More detailed studies must be accomplished prior to implementation of any features recommended in this plan.

Responsibilities - USDA, Sponsoring and Cooperating Agencies

The USDA study activities were guided and coordinated by the Nebraska Field Advisory Committee. This committee was composed of the State Conservationist, SCS, Lincoln, Nebraska; the Leader, Great

Plains Resource Program Group, ESCS, Lincoln, Nebraska; and the Staff Director, Area Planning and Programming, FS, Loveland, Colorado. The State Conservationist served as Chairman of the Field Advisory Committee. Overall coordination of the study was accomplished by a representative of the Republican River Inter-Basin Council and the Water Resources Planning Staff Leader, SCS.

The Republican River Inter-Basin Resource Council ensured that the public was informed and participated in the development of a plan for the development and improvement of water and related land resources of the basin. The Council is composed of four NRDs in the basin as follows: Upper Republican, Middle Republican, Lower Republican, and the Tri-Basin. This Council had as advisors a representative of the Republican Valley Conservation Association, Nebraska Game and Parks Commission, Nebraska State Historical Society, and the NNRC. Other organizations were asked to contribute or participate as needed. This Council provided overall guidance as well as providing liaison with the public at large.

The Council called meetings, provided necessary letters of notice, arranged for publicity as needed, arranged for meeting places, and conducted the meetings. The Council arranged for other interested public groups to make needed input to the study.

The Council participated with the USDA River Basin Planning staff, in the identification of problems and needs and in the inventory of natural, historical and archaeological resources of the basin. They provided counsel in analysis of problems and participated in the determination of alternative solutions. The Council reviewed progress and findings of the study in their Inter-Basin meetings. The Council, with the assistance of the planning staff and others as needed, resolved issues and formulated the alternative and selected plans.

The NNRC provided assistance as needed in the coordination of State agencies providing data for the study, and as available, provided field engineering services and data regarding the water pollution control problems in the basin. In addition, the NNRC planning staff made all surveys, studies and evaluations in the Wauneta Watershed. The results are incorporated in this report.

The NNRC will prepare a comprehensive management plan for the basin which encompasses the findings of the several agencies investigations and reports, including the results of this USDA Cooperative Study, and recommend a comprehensive and coordinated course of action. This activity is scheduled to be initiated in FY 1980.

Acknowledgment

Assistance and useful information was provided the USDA planning staff by the following local, State and Federal organizations:

Natural Resources Districts, Nebraska

- Upper Republican
- Middle Republican
- Lower Republican
- Tri-Basin

State of Nebraska

- Department of Health
- Natural Resources Commission
- Department of Agriculture
- Department of Environmental Control
- Department of Water Resources
- Department of Roads
- Game and Parks Commission
- University of Nebraska
  - Agricultural Experiment Station
  - Agricultural Extension Service
  - Conservation and Survey Division
  - Department of Forestry, Fisheries and Wildlife

United States Department of Agriculture

- Agricultural Research Service
- Agricultural Stabilization and Conservation Service
- Farmers Home Administration
- Statistical Reporting Service

United States Department of the Army

- Corps of Engineers, Kansas City District

United States Department of Commerce

- Bureau of Economic Analysis
- National Weather Service

United States Department of the Interior

- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey, Water Resources Division
- Heritage, Conservation and Recreation Service

United States Environmental Protection Agency

CHAPTER III
RESOURCE BASE AND EXISTING PROGRAMS

Location

The Republican River Basin, an area of 25,018 square miles (16,001,470 acres), includes all or parts of 18 counties in Nebraska, 18 in Kansas, and 8 in Colorado. The Republican River begins in northeastern Colorado, with the Arikaree River, and flows generally in a north and easterly direction entering Nebraska near the town of Haigler, where it confluences with the North Fork of the Republican River. The Republican River flows generally eastward through Nebraska for about 280 miles, leaving the State near Superior, Nebraska, then flows generally southeastward to its confluence with the Smoky Hill River where they form the Kansas River near Junction City, Kansas. The elevation ranges from about 6,000 feet in Colorado to about 1,100 feet at the mouth. Across Nebraska the valley differs in elevation from about 3,300 feet in the western section to about 1,500 feet in the eastern section and has an average gradient of 6.4 feet per mile. Major tributaries of the Republican River in Nebraska are the Arikaree River, North Fork Republican River, South Fork Republican River, Frenchman River, Red Willow Creek, Medicine Creek, Sappa Creek, Prairie Dog Creek, and Beaver Creek.

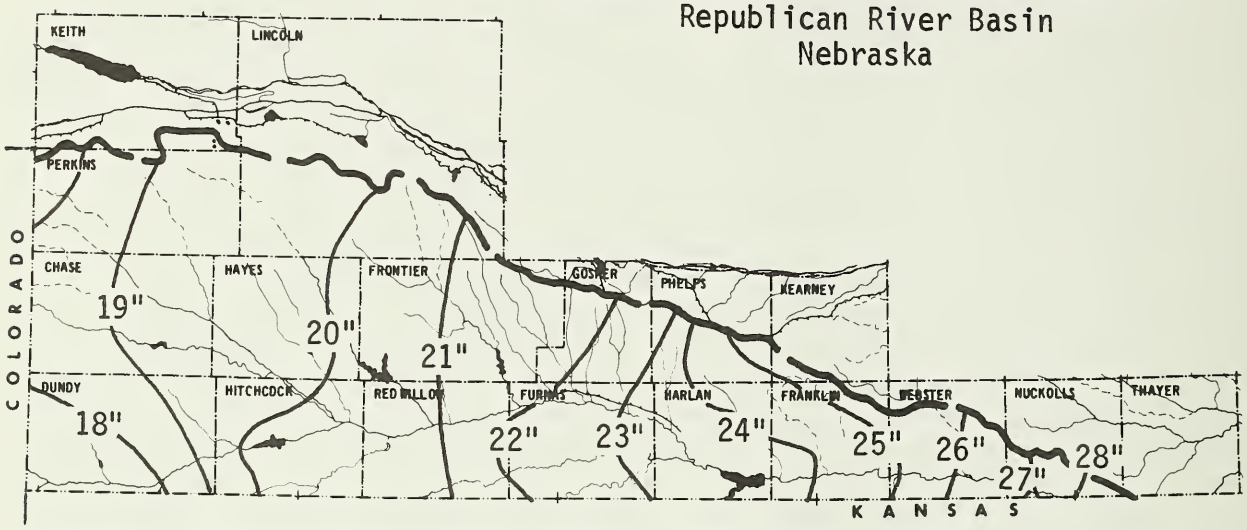
The portion of the Republican River drainage area included in this study is that part located in the State of Nebraska. This area is bounded by the Colorado and Kansas borders on the south and west and by the northern limits of the hydrologic drainage area of the Republican River Basin in Nebraska. This northern boundary of the basin begins at a point near the northwest corner of Perkins County and runs diagonally east-northeast into southern Keith County then east-southeast to the southwest corner of Thayer County. The Republican River enters Kansas near Superior, Nebraska. Seven counties (Chase, Dundy, Furnas, Harlan, Hayes, Hitchcock, and Red Willow) are located entirely within the basin. Eleven other counties partially within the basin are Franklin, Frontier, Gosper, Kearney, Keith, Lincoln, Nuckolls, Perkins, Phelps, Thayer, and Webster. About 9,712 square miles of the total drainage area of the Republican River are in Nebraska. The greatest east-west length of the basin is 223 miles while the maximum north-south distance is about 80 miles.

Climate

The Republican River Basin and adjacent areas in Nebraska have a sub-humid to semi-arid continental climate. The variable weather in the basin is typical of the interior of a large land mass in the temperate zone. Rapid weather changes are caused by invasions of larger masses of warm, moist air from the Gulf of Mexico; hot, dry air from the southwest; cool, dry air from the Pacific Ocean; and cold, dry air from Canada.

The normal annual precipitation decreases fairly uniformly from about 28 inches in the eastern part of the basin to less than 18 inches in the western part of the basin (Figure III-1). The amount of rainfall at any location generally varies considerably from month to month and

FIGURE III-1
NORMAL ANNUAL PRECIPITATION 1941-1970
Republican River Basin
Nebraska

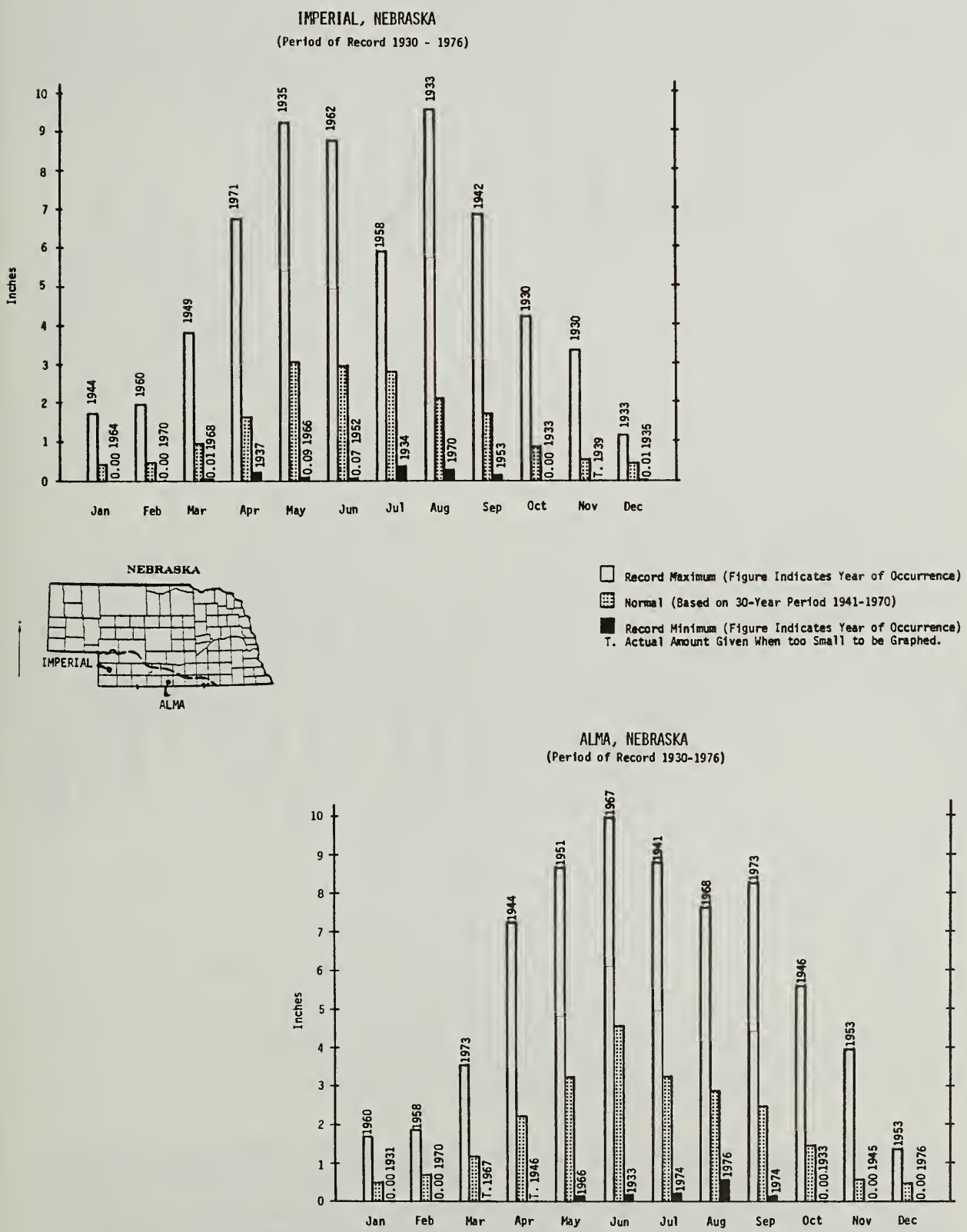


Source: Platte River Basin, Level B Study Sept. 1975
Hydrology & Hydraulics, Technical Paper

year to year. The normal monthly precipitation and extremes of record at Imperial and Alma, Nebraska, are considered to be representative of the basin and surrounding area (Figure III-2). About 70 percent of the normal annual precipitation occurs during the growing season, May through September. Normal monthly rainfall is highest in June in the eastern part of the basin, while May and June rainfalls are about equal in the western part of the basin. The average snowfall ranges from 25 inches in the eastern portion to about 32 inches in the western part of the basin. Annual accumulative minimum amounts of less than 10 inches and maximum amounts of nearly 60 inches have been recorded in and near the basin area.

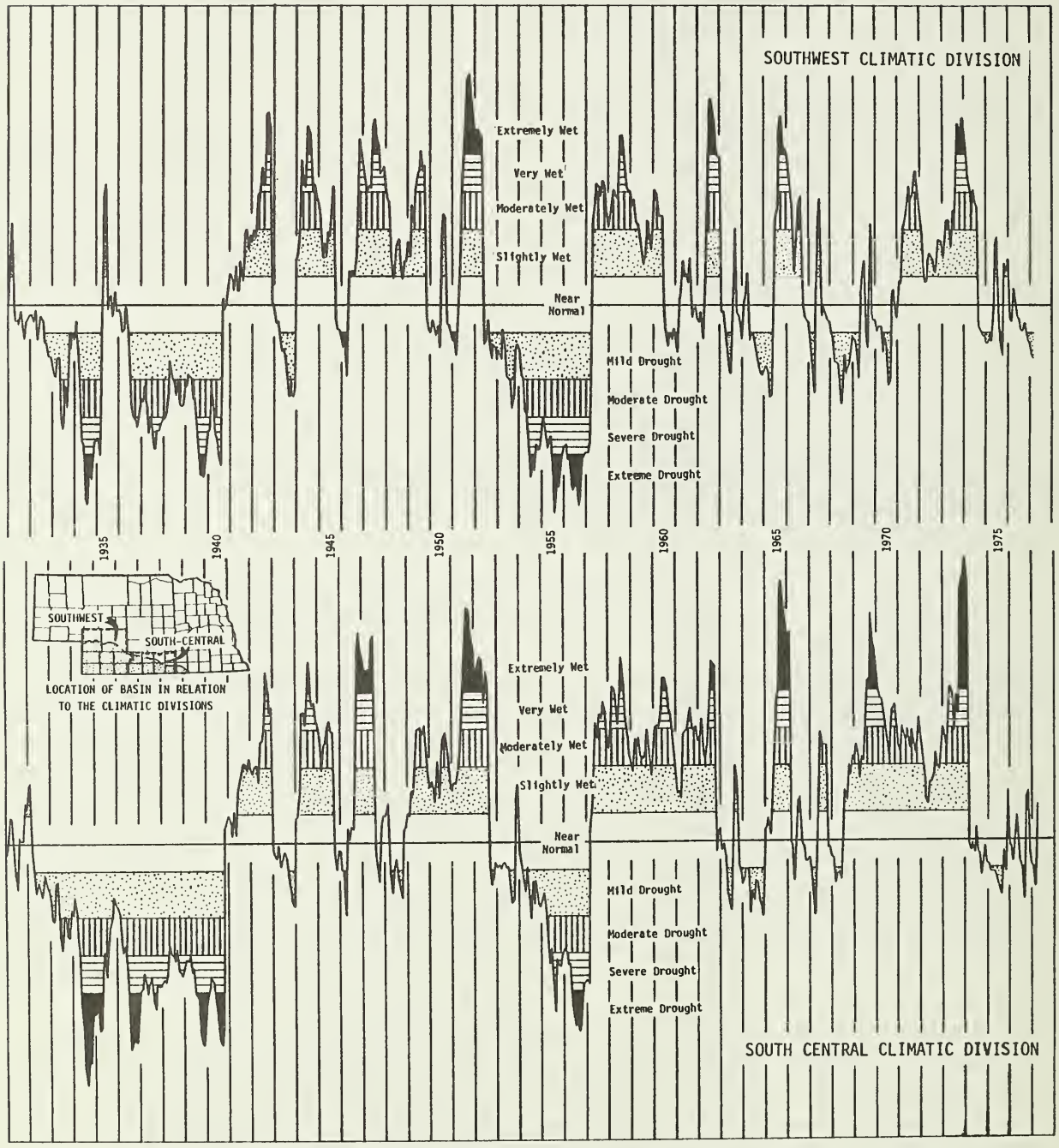
The distribution of rain throughout the growing season is generally favorable to the growing of crops even though severe storms of cloudburst intensity occur occasionally. However, as in all other areas in the Great Plains, sustained drought periods each year and frequent subnormal annual precipitation results in a need for at least some supplemental water each year for full crop production. Alternate periods of drought and wet spells of varying severity have occurred during the past 40 years. Two periods of severe drought have occurred (mid 30's and 50's) during the period of record (Figure III-3). The basin and surrounding area is frequently damaged by locally severe hailstorms. Tornadoes occur infrequently in the spring and early summer.

FIGURE III-2
MONTHLY DISTRIBUTION OF PRECIPITATION
Republican River Basin, Nebraska



Source: Department of Commerce, National Climatic Center

FIGURE III-3
DROUGHT AND WET SPELL PERIODS BY CLIMATIC DIVISIONS
Republican River Basin, Nebraska

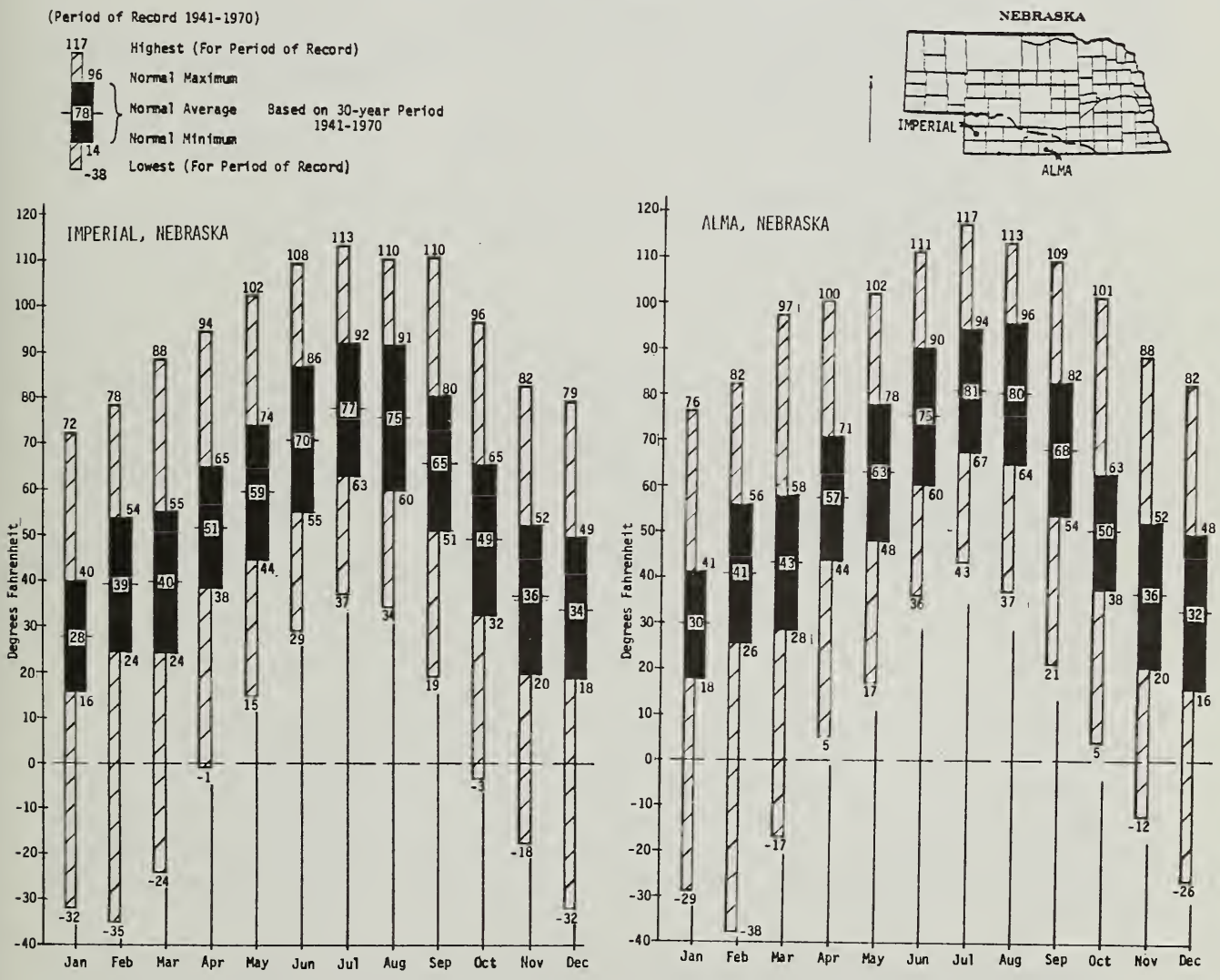


Source: Palmer Drought Index, National Weather Service

Mean annual temperature ranges from about 53° F in the southeast to about 50° F in the northwest part of the basin. Large fluctuations in daily temperatures are common in spring and summer during thunderstorm activity. Maximum temperatures of over 100 degrees occur nearly

every year in the basin. Minimum temperature of ten degrees below zero occurs nearly every year in the basin. Normal monthly maximum, minimum, average, and extreme temperatures at Imperial and Alma are shown on Figure III-4. The frost-free period (32^{0} F threshold) ranges from 145 to 165 days. The mean date of the last spring frost ranges from May 1 to May 10, while the mean date of the first fall frost ranges from October 1 to October 10.

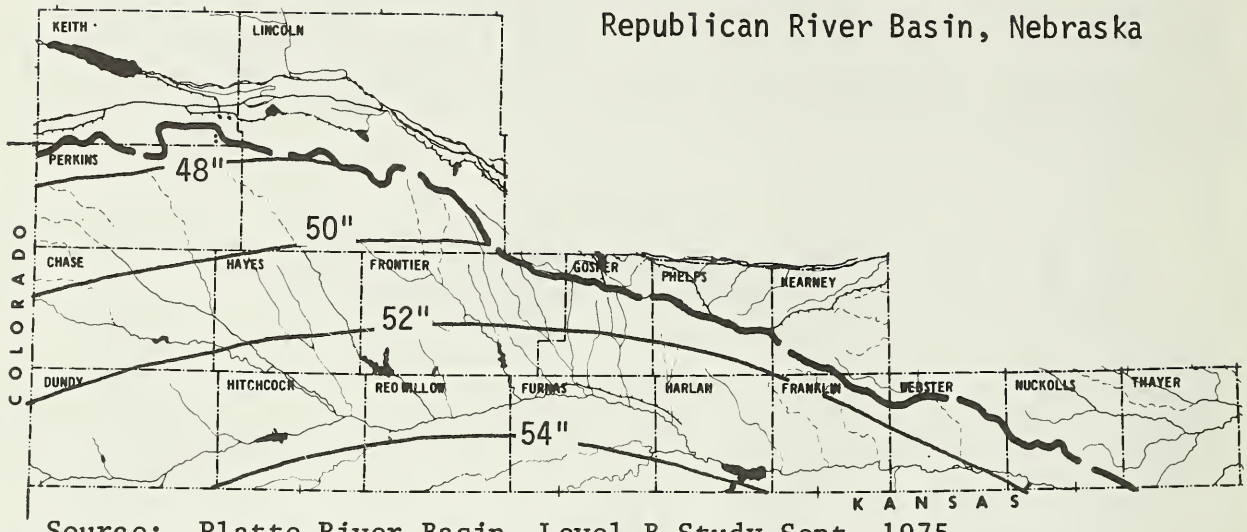
FIGURE III-4
MONTHLY DISTRIBUTION OF TEMPERATURES
Republican River Basin, Nebraska



Source: Department of Commerce, National Climatic Center

The sun shines about 68 percent of the possible time. Mean annual relative humidity is estimated to be about 62 percent. Mean relative humidity in July ranges from less than 45 percent to over 80 percent on a daily basis. Average annual gross lake evaporation ranges from about 48 inches to 54 inches in the basin (Figure III-5). The mean annual Class A pan evaporation ranges from 70 to 80 inches per year.

FIGURE III-5
AVERAGE ANNUAL GROSS LAKE EVAPORATION
Republican River Basin, Nebraska



Source: Platte River Basin, Level B Study Sept. 1975
Hydrology & Hydraulics, Technical Paper

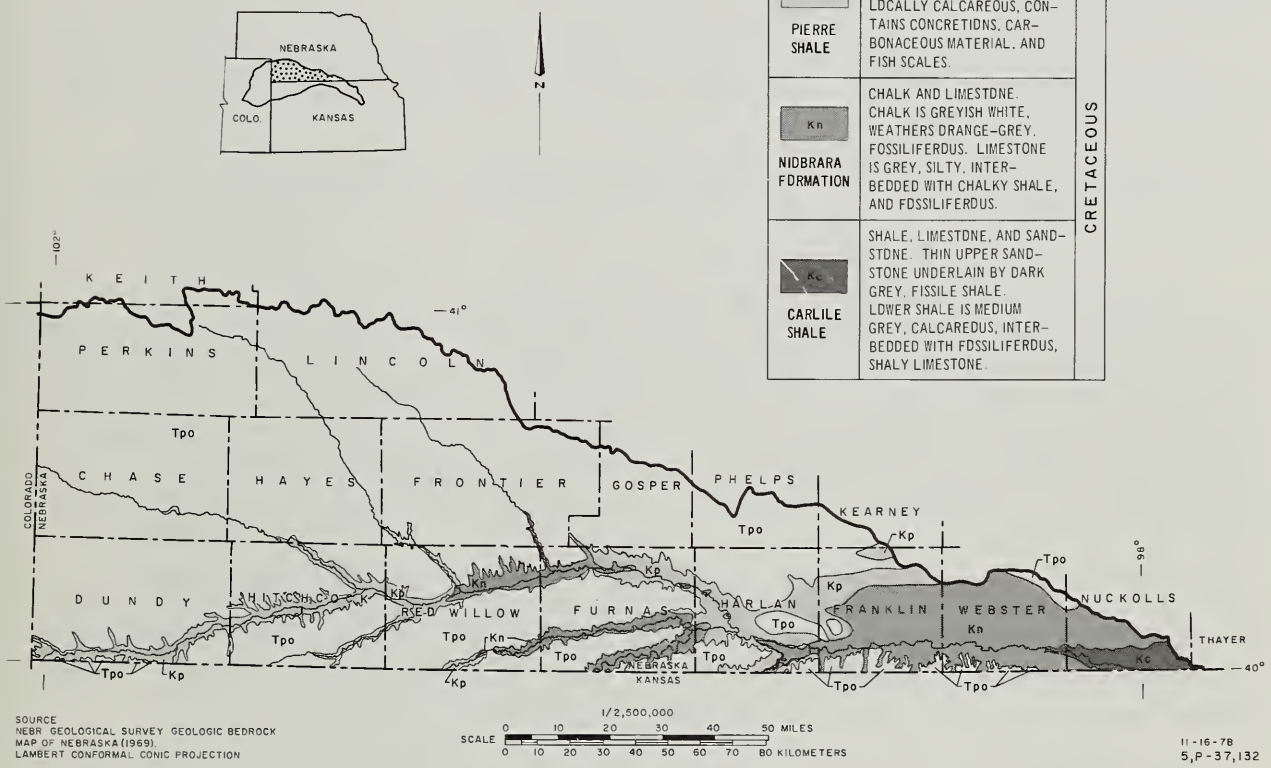
Geology

Geologic materials in the Republican River Basin occur as unconsolidated deposits of Pleistocene age overlying semi-consolidated Miocene-Pliocene deposits and consolidated Cretaceous material. The stratigraphic and spatial relationships of the various bedrock geologic units are shown in Figure III-6.

Materials of recent age in the basin include local terrace and dune sand deposits, as well as alluvium on modern stream flood plains. Pleistocene materials consist of sand, silt, clay, and volcanic ash. The western portion of the basin is covered by shallow to moderate thicknesses of wind-blown sand and silt. The eastern portion of the basin is overlain predominantly by sands and silts, beginning with coarse sand and gravel of the Grand Island Formulation and ascending through the Sappa Formation (silt and clay), Crete Formation (silty and sandy gravels), Loveland Formation (loess), and finally the Peoria and Bignell loesses. The Pleistocene sands and gravels form a moderate to substantial ground water source, particularly in the eastern part of the basin.

These deposits unconformably overlie the Ogallala Formation of Miocene to Pliocene age. It is composed basically of semi-consolidated, undifferentiated sand, silt and clay; some local deposits of quartzite and "mortar beds" of carbonate-cemented sand and silt. The Ogallala Formation is the principal aquifer in the basin. Outcrops are common along valley walls in the west and central parts of the basin.

FIGURE III - 6
BEDROCK GEOLOGIC MAP
REPUBLICAN RIVER BASIN
NEBRASKA



MAP SYMBOL AND FORMATION	LITHOLOGY	AGE
Tpo — OGALLALA FORMATION	CLAY, SILT, SAND, AND GRAVEL. VARIABLE COLORS PALE GREENISH GRAY TO YELLOW-BROWN. POORLY SORTED, LITHOLOGY VARIES LATERALLY AND VERTICALLY. SOME SANDSTONE, "MORTAR BEDS", AND SECONDARY QUARTZITE.	TERTIARY
Kp — PIERRE SHALE	SHALE, MEDIUM TO DARK GREY, OR BLACK. FISSILE, LOCALLY CALCAREOUS, CONTAINS CONCRETIONS, CARBONACEOUS MATERIAL, AND FISH SCALES.	CRETACEOUS
Kn — NIOBRARA FORMATION	CHALK AND LIMESTONE. CHALK IS GREYISH WHITE, WEATHERS ORANGE-GREY, FOSSILIFEROUS. LIMESTONE IS GREY, SILTY, INTERBEDDED WITH CHALKY SHALE, AND FOSSILIFEROUS.	CRETACEOUS
Kc — CARLILE SHALE	SHALE, LIMESTONE, AND SANDSTONE. THIN UPPER SANDSTONE UNDERLAIN BY DARK GREY, FISSILE SHALE. LOWER SHALE IS MEDIUM GREY, CALCAREOUS, INTERBEDDED WITH FOSSILIFEROUS, SHALY LIMESTONE.	CRETACEOUS

SOURCE
NEBR GEOLOGICAL SURVEY GEOLOGIC BEDROCK MAP OF NEBRASKA (1969).
LAMBERT CONFORMAL CONIC PROJECTION

1/2,500,000
SCALE 0 10 20 30 40 50 MILES
0 10 20 30 40 50 60 70 80 KILOMETERS

11-16-78
5,P-37,132

The Ogallala unconformably overlies relatively flat lying late Cretaceous marine formations. The uppermost of these is the Pierre Shale, a blackish clayey shale. Underlying the Pierre Shale is the Niobrara Formation, which consists of a massive limestone with interbedded chalky shale and a gray silty chalk. Both the Pierre Shale and Niobrara Formation are exposed along the major stream valleys in the west and central basin area; exposures of Niobrara Formation also occur in the eastern basin. At the eastern edge of the basin are some exposures of Carlisle Shale, a dark plastic clayey shale. Underlying all these formations are other formations of even older age, which are not exposed in the basin. The average thickness of all sedimentary rocks above the Precambrian basement materials is about 4,000 feet with about 1,000 feet being exposed within the basin.

According to the publication, "Inventory of Mining Operations in Nebraska", Conservation and Survey Division, Resources Report No. 7,

the principal mineral resources of the basin include widespread sand and gravel operations, ranging from a few acres in size to several hundred acres. Many of these operations are abandoned or inactive, while some are currently in production. In the west and central basin area, there are some oil field developments, particularly in Red Willow, Hitchcock and Harlan Counties. Other relatively small operations in the basin have included some limestone, sandstone and quartzite quarries, and volcanic ash pits that are currently either inactive or abandoned.

Land Resources

The USDA has developed a major land classification system that has divided the United States into Land Resource Regions which are further divided into Land Resource Areas (LRAs). These LRAs have unique characteristics of topography, soils, elevation, and precipitation. Contrasts between LRAs are usually distinct, and in some cases, very abrupt.

The basin is located in the Central Great Plains Winter Wheat Range Region and lies in three LRAs. The western 40 percent lies in the Central High Tableland LRA, about 50 percent lies in the Rolling Plains and Breaks LRA, and about 10 percent, located along the eastern part of the northern basin boundary, lies in the Central Loess Plains. Within these LRAs, the major differences are those associated with the existing soil resources. These soil resources have been grouped into soil associations that are shown on the General Soil Map, Plate 2. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soil. Soils in one association may occur in another, but in a different pattern. Soil associations found in the basin are listed below:

4. Bankard-Las-Glenberg Association: Deep, nearly level and very gently sloping, somewhat poorly, well and somewhat excessively drained, sandy and loamy soils formed in alluvium on bottom lands.

   This association is on bottom land of the Republican River and its tributaries. These soils are nearly level, however, a few low hummocky-like areas occur adjacent to the river. The composition is 50% Bankard soils, 25% Las soils, 10% Glenberg soils, and 15% other soils. The Bankard soils are excessively drained and occur as low hummocky-like areas adjacent to the river. They have a loamy fine sand or loamy sand surface layer and underlying material of calcareous loamy sand. Las soils are somewhat poorly drained and are on the lower part of this association. They have a loam surface layer and underlying material. The Glenberg soils are well drained and occur at slightly higher areas. They have a fine sandy loam surface layer overlaying a calcareous fine sandy loam material.

Most of the soils in this association are cultivated. Many areas are presently irrigated. Some areas along the Republican River are still in native grass, or a stand of trees. Maintaining fertility and managing water, wind erosion and occasional flooding are hazards in some areas.

The lack of moisture is a severe limitation in dryland farmland. Proper grazing management is needed on the soils used for range and pasture.

8. Bridget-McCook-Duroc Association: Deep, nearly level to gently sloping, well drained, silty soils formed in colluvial, alluvial and eolian silts on terraces, bottom lands and footslopes.

   The soils of this association are on stream terraces, bottom lands and adjacent footslopes of the Republican River and its tributaries. Composition is 55% Bridget soils, 25% McCook soils, 10% Duroc, and 10% other soils. The Bridget soils are on stream terraces and footslopes. They have a calcareous silt loam profile. The McCook soils commonly occur along the bottom land areas and are subject to flooding. They have a calcareous silt loam subsurface layer and underlying material. The Duroc soils are on terraces, positioned on colluvial footslopes. These soils have thick dark loam surface layers and underlying materials.

   Soils in this association are used mainly for cropland, with many areas being irrigated. Management concerns are occasional flooding on the Bridget soils on the slopes of the Republican River. Controlling wind erosion and maintaining soil fertility are needed. Some areas on the footslopes are subject to occasional flooding and erosion due to the adjacent higher lying areas.

20. Colby-Canyon Association: Deep and shallow, gently sloping to very steep, well to excessively drained, silty soils formed in loess and loamy soils formed in weathered sandstone on uplands.

   This association consists of gently sloping to very steep soils in canyons and hills along drainageways in the upper part of the basin. The composition is 40% Canyon soils, 35% Colby soils and 25% other soils. The shallow Canyon soils often occur in very steep canyon-like areas in the upper part of the drainage systems. They have a calcareous loam surface layer and sandstone underlying material. These soils have a very low available water capacity. The Colby soils have formed in silty loess material. They occupy at the very steep canyon-like areas commonly below the Canyon soils.

Due to the excessive slopes, this association is used largely for rangeland. Proper range management is needed to reduce the high soil erosion potential which exists in this association.

21. Colby-Ulysses Association: Deep, gently sloping to very steep, well to excessively drained, silty soils formed in loess on uplands.

This association consists of a dissected loess landscape of narrow ridgetops, canyons and associated narrow drainageways. Catsteps are common along the side of canyons and drainageways. The composition is about 70% Colby soils, 20% Ulysses soils and 10% other soils. Colby soils have calcareous silt loam surface layers and underlying material. Uly soils are similar except that they have a darker colored surface layer that is non-calcareous. Included in this association are stratified soils along the drainageways that are occasionally flooded.

A few areas along the ridgetops are used for cropland; however, the area is largely in rangeland. The main concerns are controlling surface runoff and soil erosion, and proper rangeland management.

23. Coly-Uly Association: Deep, gently sloping to very steep, well to excessively drained, silty soils formed in loess on uplands.

This association consists of a dissected loess landscape of canyons and narrow drainageways. Catsteps are common along the sides of the drainageways. This association consists of about 70% Coly soils, 20% Uly soils and 10% other soils. Coly soils have calcareous silt loam surface layers and underlying material. Uly soils are similar except they have a darker colored surface layer which is leached carbonate. Included in this association along the drains are the stratified Hobbs soils which are occasionally flooded.

This association is used largely as rangeland. The main concerns are controlling surface runoff and soil erosion. Proper management practices are needed in rangeland.

24. Coly-Uly-Holdrege Association: Deep, gently sloping to steep, well and somewhat excessively drained, silty soils formed in loess on uplands.

This association occurs in a dissected loess landscape of gently sloping ridgetops and steep drainageways and canyons. The composition is about 55% Coly soils, 20% Uly soils, 15% Holdrege soils, and 10% other soils. The Coly soils are on the steeper sides of the drainageways and canyons. They have a thin silt loam calcareous surface layer and underlying material. These somewhat excessively drained soils have high erosion

potential. The Uly soils occur on strongly sloping to moderately steep sideslopes. They have a silt loam surface layer and underlying subsoil. The Holdrege soils comprise areas on the less sloping sides. They are characterized by having a silt loam surface layer and a silty clay loam subsoil.

This association is used largely for rangeland; however, the less sloping areas are cultivated. The main concerns in cropland areas are controlling severe erosion potential and reducing surface runoff. Proper management practices are needed on rangeland.

42. Hastings Association: Deep, nearly level to strongly sloping, moderately well drained silty soils formed in loess on uplands.

This association occurs commonly adjacent to drainageways. The composition is about 75% Hastings. Minor soils such as Holder occupy some of the more sloping areas. These well drained soils have a silt loam surface layer and a moderately slowly permeable subsoil. The underlying material is a silt loam or silty clay loam.

This association is used largely for cultivated crops. Water erosion is a severe problem. Many of the areas have a thin surface layer due to excessive soil loss by water erosion. Maintenance of soil tilth and fertility are other management concerns.

27. Crete-Hastings Association: Deep, nearly level to gently sloping, moderately well drained soils with clayey and silty subsoils formed in loess on uplands.

The composition is about 60% Crete soils, 25% Hastings soils and 15% other similar soils. Crete soils commonly on the broad nearly level areas. They have a silty loam surface layer over a clayey slowly permeable subsoil. Hastings soils are on slightly higher areas or along drainageways. They have a silt loam surface layer and a moderately slowly permeable silty clay loam subsoil. Included in this association are a few depressional areas of the somewhat poorly drained Butler soils.

This association is used largely for cultivated crops. Many areas are irrigated. Water management, wind erosion and maintenance of soil tilth and fertility are management concerns.

33. Elsmere-Dailey Association: Deep, nearly level to gently sloping, well and somewhat poorly drained, sandy soils formed in alluvium and eolian sands in sandhill valleys.

The soils in this association occur in nearly level to gently sloping disconnected upland valleys that are surrounded by the sandy Valent soils. Composition is 45% Elsmere soils, 40% Dailey soils and 15% other soils. The Elsmere soils are in the lower part of the nearly level to undulating valleys. They have a loamy fine sand surface layer and underlying material. Elsmere soils commonly have a water table at a depth of 2 to 3 feet in the spring. The Dailey soils are in the valleys in places where drainage is better than the Elsmere soils. They commonly occur in the higher elevation landscape positions. They have a loamy fine sandy surface layer and a loamy fine sandy underlying material.

These soils are used largely for range. They are generally too sandy or have a water table too high to be successfully used for cultivated crops. Wind erosion is a severe hazard in this association. Primary concern in range management is maintaining a good vigorous stand of native grasses to keep the soils from blowing.

36. Geary-Holdrege-Kipson Association: Deep and shallow, very gently sloping to steep, well to somewhat excessively drained silty soils formed in loess and weathered shale on uplands.

This association consists of a dissected loess landscape underlain by calcareous shales on the south side of the Republican River. The composition is about 40% Geary soils, 30% Holdrege soils, 15% Kipson soils, and about 15% other soils. The Geary soils occur on sideslopes, commonly below the Holdrege soils and above the Kipson soils. The deep soils have a silt loam surface layer and a moderately slowly permeable silty clay loam subsoil. The nearly level to gently sloping Holdrege soils occupy a high portion of the landscape. These deep soils have a silt loam surface layer, moderately permeable silty clay loam subsoil. The shallow Kipson soils occur on the steepest portion of the landscape. They have a calcareous silt loam surface layer overlying shale at depth of 10 to 20 inches.

The less sloping Holdrege soils are used mainly for cultivated crops, while the sloping Geary and Kipson soils are used for rangeland and hay. Water erosion is a severe hazard in cultivated areas. Controlling runoff, reducing the risk of erosion and conserving moisture are primary concerns of management. Proper range management is needed in areas used for grazing.

37. Geary-Jansen-Meadin Association: Deep, moderately deep and shallow, gently sloping to moderately steep, well and excessively drained silty soils formed in loess, and loamy soils formed in loamy sediments underlain by sand and gravel on uplands.

This association consists of gently sloping to steep soils from ridges in valley sides of the Republican River and its tributaries. The landscape is irregular, and the hillsides are dissected by numerous uncrossable drainageways. The composition is about 40% Geary soils, 30% Jansen soils, 10% Meadin soils, and about 20% other soils. The deep Geary soils formed in silty material of the Loveland formation. They occur in the upper part of the drainage system. They have a silt loam surface layer in a slowly permeable silty clay loam subsoil. The moderately deep Jansen soils are on sideslopes of drainageways. They have about two feet of loamy material over sand and gravel. The shallow Meadin soils are on the steepest portion of the landscape. They have about 10 inches of loam overlying sand and gravel. These soils have low available water capacity.

This association is used largely for rangeland. Grain sorghum and wheat are grown on some of the sloping areas. The main concerns in management are conserving moisture, controlling runoff and reducing hazards of water erosion.

45. Hastings-Geary Association: Deep, nearly level to moderately steep, well to moderately well drained silty soils formed in loess on uplands.

The composition of this association is about 45% Hastings soils, 35% Geary soils with Jansen and Meadin soils being among the minor soils. Hastings soils are on the less sloping upper part of the landscape and have formed in loess. They have silt loam surface layers and moderately slowly permeable silty clay loam subsoil. Geary soils are on the lower more sloping part of the landscape. They have formed in the reddish brown silty Loveland material. They have silt loam surface layers and moderately slowly permeable silty clay loam subsoils. Jansen and Meadin soils are underlain by sand and gravel and are commonly on the steeper slopes.

The soils in this association are used for cultivated crops and native pasture. The more sloping areas are commonly in pasture. Severe water erosion hazard and maintenance of soil fertility are major management concerns.

46. Hastings-Holder Association: Deep, nearly level to strongly sloping, well and moderately well drained silty soil formed in loess on uplands.

This association consists of broad uniform areas on uplands. It consists of Hastings 55%, Holder 30% and other soils 15%.

Hastings soils have silt loam surface layers and slowly permeable clay loam subsoils. Holder soils have a silt loam surface layer and a moderately permeable silty clay loam subsoil.

Most of this association is suited for cultivated crops. Many areas are irrigated. Water erosion is a hazard on sloping soils. The maintenance of fertility and water management are the main concerns in irrigated areas.

48. Hersh-Valentine Association: Deep, nearly level to moderately steep, well and excessively drained, loamy and sandy soils formed in eolian sands and loams on uplands.

This association occurs in sand loess transition commonly adjacent to the sandy association. The composition is about 65% Hersh, 15% Valentine and 20% other soils. Hersh soils occur as less sloping areas. These well drained soils have a fine sandy loam surface layer and subsoil. The excessively drained Valentine soils comprise a more sloping portion of this association, having a loamy fine sand surface layer and underlying material.

Soils in this association are used mainly for cultivated crops and range. A few broad, low-lying areas are irrigated by sprinkler systems. The main concerns of management are due to the droughthy nature of the soils, soil blowing and range management.

50. Hobbs-Hord-Cozad Association: Deep, nearly level and very gently sloping, well drained, silty soils formed in loess and alluvium on bottom lands, terraces and footslopes.

The soils in this association are on stream terraces, bottomlands and footslopes, and drainageways which flow into the Republican River. Composition is about 35% Hobbs soils, 30% Hord soils, 20% Cozad soils, and 15% other soils. The Hobbs soils occur adjacent to the streams. They have stratified silt loam surface layers and underlying material. The Hord and Cozad soils occur on low stream terraces and colluvial footslopes. They have silt loam surface layers and silt loam subsoils.

The soils in this association are used mainly for cropland with many areas being irrigated. Management concerns are occasional flooding on the Hobbs soils, controlling soil blowing and maintaining soil fertility. Some areas on footslopes are subject to occasional flooding and erosion due to runoff from adjacent higher lying areas.

52. Holder-Coly-Geary Association: Deep, nearly level to steep, well to somewhat excessively drained silty soils formed in loess on uplands.

This association occurs on nearly level to gently sloping ridges and on moderately steep sides of drainageways. The composition is about 45% Holder soils, 30% Coly soils, 15% Geary soils, and 10% other similar soils. The Holder soils are on the nearly level divides that are remnants of the older, upland plain. They have a silt loam surface layer and a moderately permeable silty clay loam subsoil. These well drained soils have high available water capacity. The excessively drained Coly soils are on the steepest sides of the drainageways. They have a thin calcareous silt loam surface layer overlying calcareous silt loam material. Geary soils occur in the lower portion of the drainage system commonly along the sideslopes. They have a silt loam surface layer and a moderately permeable silty clay loam subsoil.

This association is used for cultivated crops and rangeland. The main concerns are controlling surface runoff, erosion and wind erosion. Proper management practices are needed on rangeland.

53. Holdrege Association: Deep, nearly level to strongly sloping, well drained silty soils formed in loess on uplands.

This association occurs as a broad area on the uplands. The soils are well drained except for a few small, somewhat poorly drained depressional areas. The composition is about 90% Holdrege soils and 10% other similar soils. The Holdrege soils have silt loam surface layers and moderately permeable silty clay loam subsoils. In some areas, Butler soils occur in somewhat poorly drained soils of shallow depressions.

Most of this association is suited to cultivated crop. This association has high potential for irrigation. Maintenance of soil fertility and controlling soil blowing are principal management concerns.

54. Holdrege-Coly-Nuckolls Association: Deep, nearly level to steep, well and somewhat excessively drained silty soils formed in loess on uplands.

This association consists of nearly level to gently sloping ridgetops dissected by moderately deep drainageways. The composition is about 45% Holdrege soils, 30% Coly soils, 15% Nuckolls soils, and 10% other similar soils. The well drained Holdrege soils comprise the nearly level, gently sloping ridgetops. They have silt loam surface layers and moderately permeable silty clay loam subsoils. Somewhat excessively drained Coly soils occur on the moderately steep sideslopes and drainageways. The Coly soils have calcareous soil surface layers and underlying material. The well drained to somewhat

excessively drained Nuckolls soils occur on the lower drainage systems. They have silt loam layers and silty clay loam permeable subsoils.

This association is used both for cultivated crops and for rangeland. As this soil has a high potential for erosion, controlling surface runoff is a critical management need in cultivated areas. Rangeland needs proper management practices.

55. Holdrege-Coly-Uly Association: Deep, very gently sloping to steep, well and somewhat excessively drained, silty soils formed in loess on uplands.

This association is made up of soils on upland divides and in drainageways. Soils on the divides are nearly level to sloping, and those in the drainageways are moderately steep. The composition is about 45% Holdrege soils, 25% Coly soils, 15% Uly soils, and 15% other soils. Holdrege soils are found on the nearly level divides. They have silt loam surface layers and moderately permeable silty clay loam subsoils. The excessively drained Coly soils are on the sides of the intermittent drainageways. They have calcareous silt loam surface layers on underlying material. Uly soils occupy the lower parts of some divides and the upper parts of some drainageways between areas of Holdrege and Coly soils. They have a silt loam surface layer and silt loam subsoil.

The less sloping areas are used mainly for dryland cultivation while the stronger slopes are used mainly for range. Water erosion, soil blowing and drought are the main hazards in cultivated areas. Proper management and control of water erosion are needed on rangeland.

56. Holdrege-Hall Association: Deep, nearly level and very gently sloping, well drained, silty soils formed in loess on uplands.

This association occurs as broad, nearly level to very gently sloping divides of uplands. It consists of 65% Holdrege soils, 25% Hall soils and 10% other soils. The nearly level to very gently sloping Holdrege soils have silt loam surface layers and silty clay loam subsoils. The nearly level Hall soils are similar to Holdrege except they have a thicker, darker surface layer.

This association is well suited for cultivated crops, with many areas being irrigated. Maintaining soil fertility, soil tilth and controlling wind erosion are primary concerns of management.

58. Hord Association: Deep, nearly level and very gently sloping, well drained, silty soils formed in loess on terraces and footslopes.

This association is made up of stream terraces and footslopes of the Republican River and its tributaries. This association is below the adjacent upland and above the soils on the bottom land subject to occasional flooding. The composition is about 80% Hord soils and 20% other similar soils. The Hord soils have thick, dark silt loam surface layers and underlying silt loam material. They are moderately permeable and have high available water capacity.

Most of this association is cultivated. Many areas are irrigated. Corn, alfalfa and grain sorghum are the main crops. Soil blowing and lack of sufficient moisture are the main problems in dryfarmed areas. Maintaining fertility and managing water are the main concerns in irrigated areas.

71. Kenesaw-Hersh Association: Deep, nearly level to moderately steep, well drained silty and loamy soils formed in eolian silts, loams and sands on uplands.

This association occurs on nearly level to moderately steep uplands. The composition is about 65% Kenesaw, 20% Hersh and 15% other soils. The silty Kenesaw soils are on nearly level to strongly sloping areas. Hersh soils are on the higher parts of the landscape. They have a fine sandy loam surface layer and subsoil.

The soils in this association are used mostly for cropland with small areas in range. The main concerns of management are moisture conservation, soil blowing and maintaining fertility levels.

66. Jayem-Haxtun-Rosebud Association: Deep and moderately deep, nearly level to gently sloping, well drained, loamy soils formed in eolian sands, loams and weathered sandstone on uplands.

This association commonly occurs in the sand-loess transition adjacent to the siltier soils. The landscape is commonly undulating. The composition is about 40% Jayem, 25% Haxtun, 20% Rosebud,and 15% other soils. The deep Jayem soils have formed in dark fine sandy loam materials. They have a fine sandy loam layer and subsoil. They commonly occur in the lower part of the landscape. The Haxtun soils commonly occur in slightly higher landscape positions. They have a loamy sand surface layer underlain by a sandy clay loam or loam subsoil. These Rosebud soils have formed from weathered sandstone.

They have a loam surface layer and a loam or clay loam subsoil and are underlain by the sandstone at a depth of 20 to 40 inches.

The soils in this association are used largely for cultivated crops. Primary concerns in management are wind erosion, moisture conservation and maintaining soil fertility.

67. Jayem-Keith Association: Deep, nearly level to gently sloping, well drained, loamy and silty soils formed in eolian sands, loams and loess on uplands.

Soils in this association occur in broad upland areas and in upland valleys. The area is often called the sand-loess transition area because the soils in it are made up of sandy materials and of silty loess materials. The topography is typically undulating, but broad flats and valleys are common. The composition is about 50% Jayem soils, 30% Keith soils and 20% other soils. The Jayem soils only occur in the more sloping areas. They have fine sandy loam surface layers and fine sandy loam subsoils. The silty Keith soils have silt loam surface layers and silty clay loam subsoils formed in loess material. The Keith soils commonly occur in the nearly level areas.

The soils in this association are used mainly for cropland. Many areas are irrigated. The concerns in farming these soils are controlling wind erosion and bringing about a balance between soil moisture and soil fertility. Controlling water erosion and water management are prime concerns when these soils are irrigated.

68. Jayem-Sarben-Valent Association: Deep, nearly level to moderately steep, well and excessively drained, loamy and sandy soils formed in eolian sands and loams on uplands.

This association occurs in sands loess transition commonly adjacent to the sandy associations. The landscape consists of nearly level to very gently sloping valleys with associated higher rolling sandy soils. Composition is about 40% Jayem soils, 30% Sarben soils, 15% Valent soils, and 15% other soils. Jayem soils commonly occur in the valley areas. They have fine sandy loam surface layers and underlying material. Sarben soils are similar except they have a lighter colored surface layer. The Valent soils occur on the higher, more sandy area. They have a loamy fine sand or fine sand surface layer and underlying materials.

These soils are used for cultivated crops and range. The sandy Valent soils are best suited for range due to low available water capacity and high soil blowing potential. Some of the

broader valleys of Jayem and Sarben soils are used for cultivated crops. Wind erosion, maintenance of soil fertility and moisture conservation are primary concerns of cultivated areas.

74. Kuma-Keith-Goshen Association: Deep, nearly level and very gently sloping, well drained, silty soils mainly having dark colored buried soils formed in loess on uplands.

Soils in this association comprise a broad upland landscape. The composition is about 35% Kuma soils, 30% Keith soils, 20% Goshen soils, and 15% other similar soils. The nearly level Kuma soils have a thick silt loam surface layer underlayed by a buried soil at a depth of about 15 inches of silty clay loam. The dark buried soil is enriched with plant nutrients and slows the downward movement of water in the soil profile. The Keith soils are nearly level and gently sloping areas. They have a silt loam surface layer and a silty clay loam subsoil. The Goshen soils occur in slight depressional areas. These areas commonly receive ponding of surface water following heavy rains. Goshen soils have dark silt loam surface layers and silty clay loam subsoils.

Nearly all of this association is cultivated. Many areas are in wheat or irrigated corn. Primary concerns are moisture conservation, wind erosion, maintenance of soil tilth and fertility, and water management under irrigation.

84. McCook-Munjor-Inavale Association: Deep, nearly level, well and somewhat excessively drained, silty, loamy and sandy soils formed in alluvium on bottom lands.

This association is found on the bottom lands of the Republican River and its tributaries. The soils are nearly level; however, a few low, hummocky areas occur. The composition is about 45% McCook soils, 20% Munjor soils, 15% Inavale, and 20% of other similar soils. McCook soils are moderately well drained and are on some of the highest parts of this association. They have a moderately permeable silt loam surface layer and underlying material. The Munjor soils are moderately well drained and occur at an elevation lower than the McCook soils. They have a calcareous fine sandy loam surface layer overlying a calcareous fine sandy loam underlying material. The Inavale soils are excessively drained and occur on low hummocky-like areas adjacent to the river. They have a loamy fine sand surface layer and underlying material of calcareous loamy sand.

Most soils in this association are cultivated. Many areas are irrigated with water available from shallow irrigation wells. Some areas along the Republican River are still in native grass. Maintaining fertility and managing water are concerns in irrigated areas. Soil blowing and occasional flooding are

hazards in some areas. Lack of moisture is a severe limitation to dryland farming. Proper range management is needed on soils used for grazing.

97. Nuckolls-Holdrege-Campus Association: Deep and moderately deep, very gently sloping to steep, well drained silty and loamy soils formed in loess and loamy sediments on uplands.

This association consists of alternating divides and drainageways. These intermitting drainageways are tributaries of the Republican River. Composition is about 35% Nuckolls soils, 30% Holdrege soils, 20% Campus soils, and 15% other soils. The deep Nuckolls soils were formed from silty material of the Loveland formation. These soils are commonly on sideslopes adjacent to drainageways. They have a silt loam surface layer and a moderately permeable silty clay loam subsoil. The Holdrege soils occupy the nearly level gently sloping divides. These deep soils have a silt loam surface layer and silty clay loam subsoil. The Campus soils are moderately deep. They occupy the steepest portions of the landscape. They are common along the drainageways adjacent to the streams. They have a calcareous loam surface layer and the loam subsoil underlain by calcareous residual material at a depth of 20 to 40 inches.

The soils on the divides are used mainly for dry and cultivation. Wheat and grain sorghum are the main crops. Soils on the steeper areas of the drainageways are used mainly for range. Water erosion, soil blowing and drought are the main hazards in cultivated areas. Proper management is needed to control water erosion on rangeland.

110. Rosebud-Alliance-Kuma Association: Moderately deep and deep, nearly level to gently sloping, well drained, loamy and silty soils formed in weathered sandstone and loess on uplands.

This association occurs in broad nearly level to sloping areas in the western portion of the basin. The composition is 40% Rosebud soils, 30% Alliance soils, 20% Kuma soils, and 10% other soils. Rosebud soils commonly occur in slightly higher landscaped positions. These moderately deep soils are in land by weathered sandstone at a depth of 20 to 40 inches. They have a loam surface layer and loam or clay loam subsoil. The associated Alliance soils are less sloping and are deep. They have a silt loam surface layer and a silty clay subsoil. Kuma soils commonly occur in the lower part of the landscape. They have a silt loam surface layer and dark clay subsoil.

Most of this association is used for cultivating crops. Winter wheat and irrigated corn are common crops grown. Prime concerns in cultivated areas are wind erosion, maintaining soil tilth and fertility along with water management in irrigated areas.

126. Uly-Coly-Holdrege Association: Deep, gently sloping to steep, well to somewhat excessively drained silty soils formed in loess on uplands.

This association consists of a dissected loess landscape of narrow ridgetops adjacent to steeply sloping drainageways. It consists of about 40% Uly soils, 30% Coly soils, 20% Holdrege soils, and 10% other soils. The somewhat excessively drained Uly and Coly soils comprise the sideslopes of drainageways. Uly soils have silt loam surface layers and underlying material. The Coly soils are similar, except they are calcareous in the surface layer and underlying material. The Holdrege soils occur on the less sloping upper parts of the divide. They have silt loam surface layers and silty clay loam subsoils.

The very gently and gently sloping areas of the association are dryfarmed. The rest is used mainly for range. When cultivated, the main concerns are to control surface runoff and water and wind erosion. Proper management practices are needed on rangeland.

128. Ulysses-Keith-Colby Association: Deep, very gently sloping to steep, well and somewhat excessively drained, silty soils formed in loess on uplands.

This association consists of dissected loess landscape of gently sloping ridgetops and steep drainageways. The composition is 40% Ulysses soils, 30% Keith soils, 15% Colby soils, and 15% other soils. The Ulysses soils commonly occur on the sides of the drainageway. They have a silt loam surface layer and underlying material. The Keith soils occur on the gently sloping ridgetops in the highest part of the landscape. These soils have a silt loam surface layer and a silty clay loam subsoil. The Colby soils occur on the steepest portion of the drainageways. These soils have a calcareous surface layer and underlying material.

The less sloping portions of this landscape are used for cultivated crops while the areas are largely in range. Primary concerns in management are controlling wind and water erosion, moisture conservation and maintenance of soil fertility. Grazing management is needed on rangelands.

129. Valent Association: Deep, gently sloping to very steep, excessively drained, sandy soils formed in eolian sands on uplands.

This association occurs in the sandhills portion of the basin. The terrain ranges from rolling to hilly sand dunes. The hilly dunes are rough and include catsteps and cup-shaped

areas. This association has little or no defined pattern of drainage because the rate of moisture infiltration is high. The composition is 85% Valent soils and 15% similar soils. The Valent soils have light colored, loamy fine sand surface layers and calcareous loamy fine sand or loamy fine underlying materials. These soils are excessively drained and have a low available water holding capacity. Dailey soils occur in the less sloping valley area. The soils in this association are too sandy, and the terrain is too rough for cultivated crops.

Nearly all of this association is in native grass range. There is a hazard of these sandy soils blowing even when they are in range. Thus, proper range management is of prime concern.

132. Valent-Tassel Association: Deep and shallow, nearly level to very steep, excessively drained, sandy soils formed in eolian sands and weathered sandstone on uplands.

This association consists of gently sloping soils in the valleys and hilly soils on the adjacent more sloping areas. The valley areas are small in size and irregular in shape. Composition is about 70% Valent soils, 20% Tassel soils and 10% other soils. The Valent soils occur in the rolling to hilly sandy areas. They have a fine sand surface layer and calcareous underlying fine sand material. The shallow Tassel soils occur in the gently sloping valley-like areas. These soils are underlain by weathered sandstone at depths of 10 to 20 inches. They have a loamy sand or loamy fine sand surface layer over a fine sandy loam material with soft sandstone occurring at a depth of about 15 inches.

This association is used mainly for range. The soils are either too sandy or too shallow for successful dryland cropland. Good range management practices are needed.

133. Valentine Association: Deep, gently sloping to very steep, excessively drained, sandy soils formed in eolian sands on uplands.

This association occurs in the sandhill portion of the Republican River Basin. The slopes range from nearly level in the long narrow valleys to steep on the higher dune-like areas. The hilly areas are rough and include catsteps. The drainage pattern is not well established in this association. The composition is about 85% Valentine soils and 15% other soils. The Valentine soils have loamy fine sandy or fine sand surface layers and underlying materials. Included in the association in some of the valleys are the less sloping Dunday soils.

Soils in this association are too sandy, and the topography is too rough for elevated crops. Nearly all of this association is in native grass range. There is a hazard of the sandy soils blowing even when they are in range unless good range management practices are used.

127. Uly-Holdrege-Coly Association: Deep, gently sloping to steep, well and somewhat excessively drained, silty soils formed in loess on uplands.

This association occurs on a dissected loess landscape. Composition is 35% Uly soils, 30% Holdrege soils, and 20% Coly soils. The Uly soils occur on the strongly sloping sideslopes. They have a silt loam surface layer and subsoil. The Holdrege soils are on the gently sloping ridgetops. They have a silt loam surface layer and a silty clay loam subsoil. The steep Coly soils have a silt loam surface layer and underlying material.

Holdrege soils are used mainly for cultivated crops. The Uly and Coly are used for rangeland. Water erosion is a severe hazard in cultivated areas. Proper range management is needed in areas used for grazing.

Soil surveys have been completed and maps prepared showing these associations on about 5.1 million acres or 82 percent of the basin as of January 1, 1978. With the exception of Keith and Perkins Counties, soil surveys for the balance of the basin will be completed by 1981.

Within each of the soils associations, there is an additional classification of the soil resource. This is a capability classification which is a practical method of grouping soils for use, treatment and management. There are eight general classifications (Class I through Class VIII). The hazards and limitations on use are as follows:

Class I: Soils with few limitations that restrict their use when cultivated.

Class II: Soils with minor limitations that restrict their use. Easily applied conservation measures are needed when cultivated.

Class III: Soils with severe limitations and require special conservation measures when cultivated.

Class IV: Soils with very severe limitations, require intensive conservation measures and very careful management if occasionally cultivated.

Class V: Soils with no erosion hazard. They are wet or subject to overflow. Their use is limited to pasture, range, riparian forests, woodland, or wildlife.

Class VI: Soils with limitations that make them normally unsuited for cultivation. Their use is limited to long term range, forest or woodland, wildlife or recreation uses. Seeding or reseeding is practical.

Class VII: Soils with very severe limitations that limit their use to range, forest or woodland, wildlife or recreation. Reseeding is generally not practical.

Class VIII: Soils that are not suited to agricultural production. They have value for forest, wildlife and recreation.

The above capability classes are further divided into subclasses that show the principal kinds of problems involved. The subclasses are: erosion as indicated by e, such as IIIe, wetness indicated by w, such as Vw, soil limitations (shallow, droughty or saline) indicated by s, such as IVs, and climatic limitations indicated by c, such as IIc.

Table III-1 shows the present major land use by Land Capability Classes in the Republican River Basin. About 5 percent of the soils are in Class I. They are suited for a wide range of plants and can be safely cultivated by following good soil management practices. When Class I soils are irrigated with gravity systems, some land leveling and reshaping of the surface may be necessary in order to obtain more uniform applications of water. About 5,700 acres of Class I land are used for pasture and range, and unless these lands occur in small areas or in locations not practical to cultivate, much of this land could be used for cropland.

About 32 percent or 1.9 million acres of the soils in the basin are in Land Capability Class II. When cultivated, Class II lands need a conservation cropping system with minimum tillage and crop residue management to improve and maintain the soil in good physical condition. Presently, over 224 thousand acres of Class II land are used for pasture and rangeland. Much of this land is suitable for the production of cultivated crops, its conversion limited by the type of agricultural enterprise or by being isolated in small areas, and, consequently, not large enough to make a desirable cultivatable unit.

Over 11 percent, 679 thousand acres, of the soils in the basin are in Land Capability Class III. Water erosion is the major hazard. Conservation cropping systems with minimum tillage, crop residue management, contour farming, terraces, and grassed waterways are needed if these lands are cultivated. Alternate uses of Class III land are pasture, forest and wildlife habitat. Over 111 thousand acres of Class III lands are used for pasture and forest land. Much of this land

GENERAL SOIL MAP

REPUBLICAN RIVER BASIN

NEBRASKA

LEGEND

- STATE BOUNDARY
- COUNTY BOUNDARY
- TOWN OVER 5,000
- TOWN 0-4,999
- DRAINAGE
- DAM AND LAKE
- U S HIGHWAY
- STATE HIGHWAY
- RAILROAD
- BASIN BOUNDARY

N

SOIL ASSOCIATIONS

BANKARD-LAS-GLENBERG ASSOCIATION Deep, sandy level and very gently sloping, somewhat poorly, well and somewhat excessively drained, sandy and loamy soils formed in alluvium on bottom lands

8 BRIDGER-MC COOK-DUROC ASSOCIATION Deep, nearly level to gently sloping well drained, silty soils formed in chilhowee, alluvial, and eolian silts on terraces, bottom lands, and foot slopes

20 COLBY-CANYON ASSOCIATION Deep and shallow, gently sloping to very steep, well to excessively drained, silty soils formed in loess and loamy soils formed in weathered sandstone on uplands

21 COLBY-ULYSSES ASSOCIATION Deep, gently sloping to very steep, well to excessively drained, silty soils formed in loess on uplands

23 COLY-ULY ASSOCIATION Deep, gently sloping to very steep, well to excessively drained, silty soils formed in loess on uplands

24 COLY-ULY-HOLDREGE ASSOCIATION Deep, gently sloping to steep, well and somewhat excessively drained, silty soils formed in loess on uplands

CRETE-HASTINGS ASSOCIATION Deep, nearly level to gently sloping, moderately well drained soils with clayey and silty subsoils formed in loess on uplands

ELSMERE-DAILEY ASSOCIATION Deep, nearly level to gently sloping, well and somewhat poorly drained, sandy soils formed in alluvium and eolian sands or sand and gravel

GEARY-HOLDREGE-KIPSON ASSOCIATION Deep and shallow, very gently sloping to steep, well to somewhat excessively drained silty soils formed in loess and weathered shale on uplands

CEARY-JANSEN-MEADIN ASSOCIATION Deep, moderately deep and shallow, gently sloping to moderately steep, well and excessively drained silty soils formed in loess and loamy soils formed in loamy sediments underlain by sand and gravel on uplands

42 HASTINGS ASSOCIATION Deep, nearly level to strongly sloping, moderately well to moderately well drained silty soils formed in loess on uplands

45 HASTINGS-GEARY ASSOCIATION Deep, nearly level to moderately steep, well to moderately well drained silty soils formed in loess on uplands

46 HASTINGS-HOLDER ASSOCIATION Deep, nearly level to strongly sloping, well and moderately well drained silty soils formed in loess on uplands

48 HERSH-VALENTINE ASSOCIATION Deep, nearly level to moderately steep, well and excessively drained, loamy and sandy soils formed in eolian sands and loams on uplands

50 HOBBS-HORD-COZAD ASSOCIATION Deep, nearly level and very gently sloping, well drained, silty soils formed in loess and alluvium on bottom lands, terraces, and foot slopes

52 HOLDER-COLY-GEARY ASSOCIATION Deep, nearly level to steep, well to somewhat excessively drained silty soils formed in loess on uplands

53 HOLDREGE ASSOCIATION Deep, nearly level to strongly sloping, well drained silty soils formed in loess on uplands

54 HOLDREGE-COLY-NUCKOLLS ASSOCIATION Deep, nearly level to steep, well and somewhat excessively drained, silty soils formed in loess on uplands

55 HOLDREGE-COLY-ULY ASSOCIATION Deep, nearly level to steep, well and somewhat excessively drained, silty soils formed in loess on uplands

58 HOLDREGE-HALL ASSOCIATION Deep, nearly level and very gently sloping, well drained, silty soils formed in loess on uplands

HORD ASSOCIATION Deep, nearly level and very gently sloping, well drained loamy soils formed in loess, colluvium and foot slopes

JANSEN-HASTIN-ROSEBUD ASSOCIATION Deep and moderately deep, nearly level to gently sloping, well drained, loamy soils formed in eolian sands, loess and weathered sandstone on uplands

JANSEN-KEITH ASSOCIATION Deep, nearly level to gently sloping, well drained loamy and silty soils formed in eolian sands, loams and loess on uplands

JANSEN-SARGENT-VALENTINE ASSOCIATION Deep, nearly level to moderately steep well and excessively drained, loamy and sandy soils formed in eolian sands and loams on uplands

KENESAW-KIPSON ASSOCIATION Deep, nearly level to moderately steep, well drained silty and loamy soils formed on eolian silts, loams and sands on uplands

KUMA-KEITH-GOSHEN ASSOCIATION Deep, nearly level and very gently sloping well drained, silty soils formed in dark colored alluvial soils formed on loess on uplands

MC COOK-MUNJOR-IMAVALE ASSOCIATION Deep, nearly level, well and somewhat excessively drained, silty, loam and sandy soils formed on alluvial on bottom lands

97 NUCKOLLS-HOLDREGE-CAMPUS ASSOCIATION Deep and moderately deep, very gently sloping to steep, well drained silty and loamy soils formed in loess, limestone and silty residuum on uplands

ROSEBUD-ALLIANCE-KUMA ASSOCIATION Moderately deep and deep, nearly level to steep, well drained, loamy and silty soils formed in weathered sandstone and loess on uplands

126 ULY-COLY-HOLDREGE ASSOCIATION Deep, gently sloping to steep, well to somewhat excessively drained silty soils formed on loess on uplands

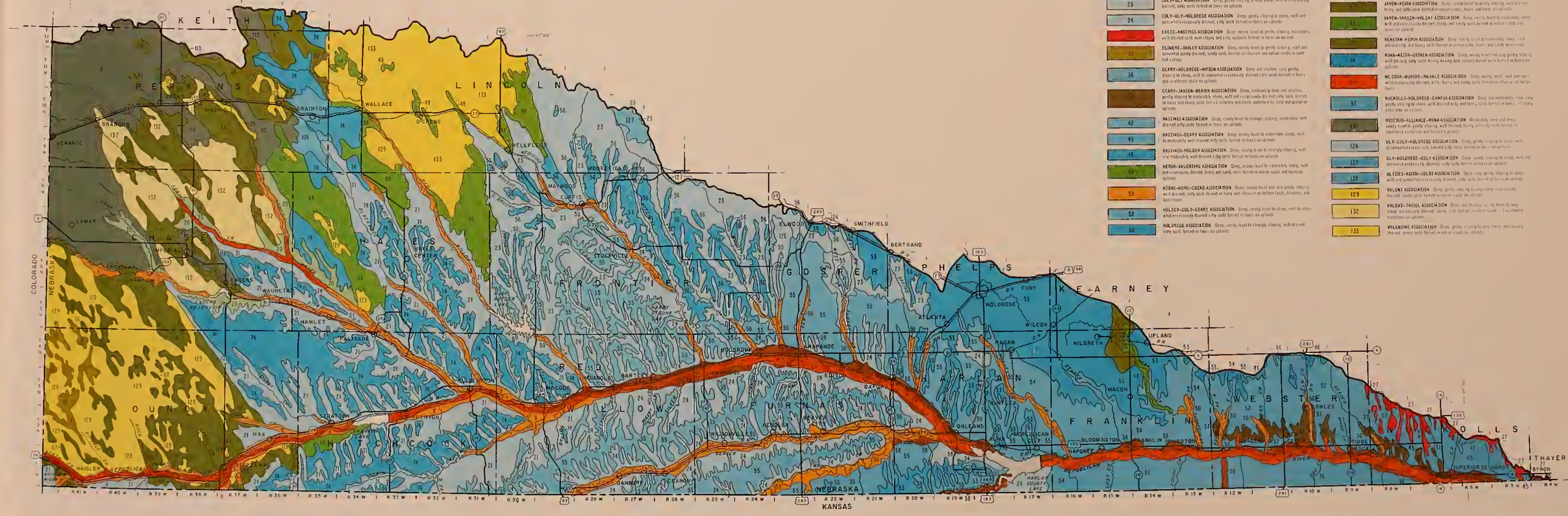
127 ULY-HOLDREGE-COLY ASSOCIATION Deep, gently sloping to steep, well and somewhat excessively drained, silty soils formed in loess on uplands

128 ULYSSES-KEITH-COLBY ASSOCIATION Deep, very gently sloping to steep, well and somewhat excessively drained, silty soils formed in loess on uplands

129 VALENT ASSOCIATION Deep, gently sloping to very steep, excessively drained, sandy soils formed in eolian sands on uplands

132 VALENT-TASSEL ASSOCIATION Deep and shallow, nearly level to very steep, excessively drained, sandy soils formed in eolian sands and weathered sandstone on uplands

133 VALENTINE ASSOCIATION Deep, gently sloping to very steep, excessively drained, sandy soils formed in eolian sands on uplands



SOURCE
BASE MAP FROM SCS DRAG NO. 5,R-34,51917-781*
SOILS FROM SCS DRWG NOS. 5,5-36,88812-781
AND 5,5-37,06910-781
*TRANSVERSE MERCATOR PROJECTION

SCALE 1/800,000
0 5 10 15 20 25 30 MILES
0 5 10 15 20 25 30 35 40 45 KILOMETERS

PLATE 2

5,R-37,188

TABLE III-1 MAJOR LAND USES BY LAND CAPABILITY CLASSES AND SUBCLASSES
Republican River Basin, Nebraska

Land Class & Subclass	Cropland Nonirr.	Cropland Irrig.	Pasture & Range	Forest	Other	Total Agri.	Non. Agri.	Total
	(Thousands of Acres)							
I	21.5	261.8	5.7	2.0	3.9	294.9		
IIc	24.9	--	3.6	--	1.2	29.7		
IIe	1299.4	192.1	196.1	6.5	32.1	1726.2		
IIs	19.1	31.7	1.1	--	--	51.9		
IIw	31.3	18.3	23.4	10.1	4.0	87.1		
IIIe	517.5	19.4	108.9	.7	11.0	657.5		
IIIs	7.4	5.1	1.4	--	.6	14.5		
IIIw	6.7	--	.5	--	--	7.2		
IVe	306.2	39.5	243.5	.3	11.7	601.2		
IVs	3.6	1.0	3.8	.5	.3	9.2		
IVw	3.5	.8	14.5	--	--	18.8		
Vw	.4	--	4.8	3.3	5.7	14.2		
VIe	216.3	8.4	1818.2	.3	18.1	2061.3		
VIs	.4	--	6.5	3.2	--	10.1		
VIw	21.7	--	72.3	11.8	5.6	111.4		
VIIe	1.0	--	303.9	--	1.5	306.4		
VIIs	1.1	--	13.6	--	.3	15.0		
VIIIs	--	--	.2	1.3	1.8	3.3		
Total	2482.0	578.1	2822.0	40.0	97.8	6019.9	195.6	6215.5

is suitable for cropland. Proper use of pastures and good management and adequate fire protection of woodland and wildlife areas are required to maintain sufficient cover to retard soil loss and reduce runoff.

Nearly 11 percent, 629 thousand acres, of the soils in the basin are in Land Capability Class IV. About one-half, 355 thousand acres, of the Class IV land is used for cultivated crops. Water erosion is the major hazard. Most of the lands in Class IV are sloping with various degrees of erosion. The number of years that Class IV soils are continuously cultivated should be limited. The cropping systems needed consist mostly of close grown crops with tillage operations that will leave sufficient crop residue on the surface. Pasture, forest and wildlife habitat are also desirable uses of these lands.

There are about 14,200 acres or less than one-fourth of one percent of the agricultural land that are in Land Capability Class V. Most of the Class V lands in the basin have a high water table,and nearly all are used for pasture and range and/or wildlife habitat.

About 2.2 million acres of 36 percent of the agricultural land in the basin are in Land Capability Class VI. These soils are not normally suited for cultivation. Some of the Class VI lands are on the steep slopes bordering the bottom lands or are adjacent to stream courses. They contribute large amounts of sediment to flood plains and to stream channels. These steep areas should be used for range or planted to trees and shrubs which, under proper management, will provide a permanent cover and materially reduce runoff and soil erosion. There are also large areas of sandy soils that are highly subject to wind erosion if cropped or overgrazed. About 11 percent or 247 thousand acres of these Class VI soils are being cropped and should be converted to permanent cover. When these areas are isolated in cropland or in irrigated areas, special management practices of mulching, shaping or other intensive practices are needed to control wind and water erosion.

Class VII lands occupy 321 thousand acres of about 5 percent of the basin area. These lands are unsuited to cultivation. Their use is largely restricted to pasture, forest or wildlife habitat. Most of the Class VII lands in the basin are now in pasture, range and forest land. Proper use and careful management are necessary for adequate treatment. Areas of Class VII land in crops should be seeded to grasses or planted to trees for permanent cover. There are 3,300 acres of Class VIII land in the basin that are not suited for agricultural production but have value for recreation and wildlife.

About 97 percent of the area in the basin is used for agricultural purposes. Of this, 51 percent is cropland, 47 percent is pasture and rangeland, and less than 1 percent is forest land. The balance of the agricultural area, 2 percent, consists of farmsteads, idle land, wildlife areas, water, and miscellaneous areas not otherwise classified.

Over 3 million acres of cropland exist in the basin, including 578.1 thousand acres of irrigated cropland. The principal crops grown in the basin are corn, grain sorghum, winter wheat, soybeans, and alfalfa hay.

Most of the 2.8 million acres in grassland are classified as rangeland. There are some pastures of introduced grasses and legumes on small tracts of the better soils, some of which are irrigated. Rangeland, land used for grazing livestock and on which the climax (natural potential) plant community exists, is dominated by native grasses and associated forbs.

The forested land in the basin amounts to about 40 thousand acres, less than 1 percent of the agricultural area. The forested areas occur mainly on bottom lands or in narrow fingers adjacent to drainageways. A small amount of the forested land in the basin is utilized for commercial wood products. The common species are eastern cottonwood, boxelder, green ash, oaks, and black walnut. Field shelterbelts and farmstead windbreaks include species such as eastern red cedar, rocky mountain juniper, common hackberry, thornless honey locust, green ash, Siberian elm, eastern cottonwood, ponderosa pine, Austrian pine, and various shrubs. All of these areas are important for their ability to trap sediment, stabilize stream courses and stream banks and to provide recreation, wildlife habitat and forage, and to provide shade and shelter to livestock.

About 3 percent of the total basis area is nonagricultural land and consists of urban developments, roads and railroads, large water areas, and miscellaneous uses.

Prime Farmland

There are about 2.9 million acres of prime farmland in the basin (Table III-2). Prime farmland is land best suited for producing food, feed, forage, fiber, and oilseed crops, and also available for these uses (the land could be cropland, pastureland, rangeland, forest land, or other land but not urban or built-up land or water). These lands have

Typical Prime Agricultural Land Suitable for Intensive Cropping

TABLE III-2 PRIME AGRICULTURAL LAND BY LAND USE
Republican River Basin, Nebraska

Land Class & Subclass	Cropland		Pasture & Range	Forest	Other	Total
	Nonirr.	Irrig.				
	(Thousands of Acres)					
I	21.5	261.8	5.7	2.0	3.9	294.9
IIc	24.9	--	3.6	--	1.2	29.7
IIe	1,299.4	192.1	196.1	6.5	32.1	1,726.2
IIs	19.1	31.7	1.1	--	--	51.9
IIw	31.3	18.3	23.4	10.1	4.0	87.1
IIIe	517.5	19.4	108.9	.7	11.0	657.5
IIIs	7.4	5.1	1.4	--	.6	14.5
TOTAL	1,921.1	528.4	340.2	19.3	52.8	2,861.8

Source: USDA Conservation Needs, Nebraska, 1969, adjusted for land use.

the soil quality, growing season and moisture supply needed to produce sustained high yields of crops economically when treated and managed, including water management, according to modern farming methods.

It is important to emphasize that prime farmland is one of the most important resources of the basin. This exceptional land can be farmed continuously without degrading the environment. It will produce the most food, feed, etc., with the least amount of energy used. It responds exceptionally well to fertilizer and other chemical applications with limited loss of residues by leaching or erosion. This land has the highest percentage of soils that can be intensively farmed. It is the most responsive to management and requires the least investment for maintaining productivity.

There are other lands, in addition to prime farmland, that are of importance for the production of food, feed, fiber, forage, and oilseed crops. Acreages of these soils are not included in the aforementioned area. Soils in this category are important to agriculture yet they exhibit some properties that exclude them from prime farmland. Examples of such properties are seasonal wetness, erodibility, limited rooting zone, frequent flooding, or droughtiness. These soils can be farmed satisfactorily by greater inputs of fertilizer and soil amendments, drainage improvement, erosion control practices or flood protection. Fair to good crop yields can be obtained when managed properly.

Irrigable Lands

Development of irrigation has been progressing at a rapid pace in the basin. The potential for irrigation depends on the availability of land as well as the availability of water. Irrigable lands have been generally identified from the USDA Conservation Needs Inventory. Table III-3 indicates that over 3.0 million acres of land are classed as

TABLE III-3 IRRIGABLE LANDS
Republican River Basin, Nebraska

Class	Irrigation Limitations: Slight to Moderate	Irrigation Limitations: Severe	Total	Irrigated 1975	Irrigable Remaining
	(Thousands of Acres)				
I	286	--	286	262	24
II	1,711	--	1,711	244	1,467
III	--	572	572	18	554
IV	--	447	447	45	402
VI	--	--	--	9	--
TOTAL	1,997	1,019	3,016	578	2,447

being irrigable. Of this amount, an average of about one-fifth or 578,000 acres were irrigated during the period 1972-1975. Recent data establishes that substantially higher amounts were irrigated in 1977. Class I and II lands would have only slight to moderate limitations and constitute 66 percent of the irrigable lands in the basin. About one-fourth of this area is currently irrigated. There are another one million acres of irrigable land with severe limitations. About six percent of this area was irrigated.

Forest Resources

The cottonwood forests, which dominate the river bottoms of the Republican River Basin in Nebraska today, are the result of past floods. The floods created sandbars and other areas of bare wet soil ideal for the establishment and development of stands of willow and cottonwood. Green ash, hackberry, mulberry, boxelder, and eastern red cedar are the most common associated species. Successive periods of flooding with

deposition of sandy sediments and high water tables through a large part of the growing season tend to favor willow and cottonwood since they survive the sedimentation and saturated soils best.

Dams now control the river flows to the extent that floods will no longer destroy old vegetation and replace it with new sediment depositions. Thus, significant areas of natural cottonwood reproduction are not likely to occur. Instead, as the existing cottonwood stands mature and begin to thin out, the associated tree species begin to appear as an understory. The exact composition of the understory is determined by soil texture, depth of water table, seed source and extent of grazing. Heavy grazing on drier sites generally results in picturesque park-like stands with grass but no understory of tree regeneration. These will not exist forever; the cottonwood will mature and die. On the wet sites, heavy grazing will inhibit regeneration of hackberry and green ash while not affecting the growth of vines and briars. Without grazing, the cottonwood stands on the better sites (loamy or silty soils) at the east (lower) end of the basin will evolve toward a mixture of elm, green ash, cottonwood, hackberry, and boxelder.

Significant areas of forest land have been cleared for agricultural purposes in the last two decades. In 1955, the area of forest land in the basin was estimated to be 56,000 acres; 47,100 acres in 1969, and currently about 40,000 acres of forest land.

Surface Water Resources

The surface area of water in the basin is about 43,000 acres. Of this amount, about 24,000 acres are contained in reservoirs over 40 surface acres. There are nearly 17,000 acres in river, streams and small ponds under 40 acres, which include numerous small structures built for various purposes, such as livestock water, irrigation reuse, erosion control, fish and wildlife, and local flood control. It is estimated that in the basin, there are about 9,000 of these structures, averaging about 1.4 acres in size with approximately 85 acres drainage area. There are no large natural lakes in the study area. However, there are 2,084 acres of water occurring in Type 4 and 5 natural wetlands (Table III-4).

Principal tributaries of the Republican River that influences flow through Nebraska are the Arikaree River, draining about 1920 square miles, the North Fork Republican River, draining about 2000 square miles, South Fork Republican River, confluence near Benkelman, draining about 2,730 square miles, Frenchman River, confluence near Culbertson, draining about 3,760 square miles, Red Willow Creek, confluence near Indianola, draining about 740 square miles, Medicine Creek, confluence near Cambridge, draining about 870 square miles, Sappa Creek, confluence near Orleans, draining about 2,110 square miles, Prairie Dog Creek, confluence near Alma, draining about 1,010 square miles, and Beaver Creek

TABLE III-4 WATER AREAS - 1975
Republican River Basin, Nebraska

:	Lake or Reservoir	: Acres
Over 40 Surface Acres		
County		
Chase	Enders Reservoir	1,707
Dundy	Rock Creek Lake & Hatchery	75
Hitchcock	Swanson Reservoir	4,974
Hayes	Hayes Center Lake	40
Frontier	Hugh Butler Reservoir	1,628
	Harry Strunk Reservoir	1,768
Lincoln	Wellfleet Lake	49
Harlan	Harlan County Reservoir	13,700
Subtotal		23,941
Under 40 Surface Acres		
Description		
Small Farm Ponds		13,897
Irrigation Tailwater Pits		687
Rivers and Streams		2,287
Subtotal		16,871
Inland Deep-Fresh Marshes and Inland Open-Fresh Water Basins		
Description		
Types 4 and 5 Natural Wetlands 1/		2,084
TOTAL AREA, WATER		42,896

Source: U.S. Bureau of Census; Soil Conservation Service, USDA; Bureau of Reclamation, U.S. Dept. of the Interior and Corps of Engineers, and Nebraska Game and Parks Commission "Survey of Habitat" Work Plan K-71, 1972.

1/ As defined in U.S. Fish and Wildlife Service Circular 39.

confluence near Beaver City, draining about 1,950 square miles. The total Republican River drainage area, as it leaves Nebraska, is 25,018 square miles of which about 7,500 square miles are noncontributing. About 9,712 square miles of the total basin lie in Nebraska. Red Willow and Medicine Creek are the two major tributaries that originate in Nebraska.

Surface Water Supply

Streams originating in the sandhills, such as Red Willow Creek, Medicine Creek and Frenchman River, have relatively constant base flow, but most other tributaries experience a wide variation in flow, depending upon the amount of precipitation runoff.

Because of the semiarid climate and the disastrous Republican River flood in 1935, there has been considerable surface water development on the Republican River. Because of the modifications to the natural flow by surface storage projects and irrigation diversion, an analysis of the existing stream gages would not be meaningful. However, the Republican River Compact Administration was formed to administer the water of the river between the States of Colorado, Nebraska and Kansas. The administration computes the annual virgin water supply for the basin and then determines allocations for each State based on the present supply and compact agreement. The computed annual water virgin supply for 1976 and the 10-year average for the 1967-1976 period in acre feet by drainage basins is shown in Table III-5.

The Republican River Compact Administration computed base virgin water supply. The States water allocation, based on the computed virgin water supply, is shown later in this report.

Surface Water Developments

The Republican River Basin has been subjected to intensive development of surface water storage projects constructed for various purposes. The larger projects have been built for the following purposes: irrigation, flood control, fish and wildlife, and recreation.

In addition to the developments in Nebraska, some of the larger projects developed in the Republican River Basin are in the Colorado and Kansas areas of the basin. A brief description of these projects by States is necessary because of their influence on surface-water flows.

Surface Water Developments in Colorado

The U. S. Bureau of Reclamation (USBR) constructed Bonny Reservoir on the South Fork of the Republican River near Hale, Colorado. The main purpose of the reservoir is for irrigation and flood control. The total capacity of the reservoir is 170,160 acre feet with 1,420 acre

TABLE III-5 ANNUAL VIRGIN WATER SUPPLY
Republican River Basin, Nebraska

Drainage Area	1976	10 Year Average 1967-1976
	(Acre-feet)	
Prairie Dog Creek	16,780	21,760
Sappa Creek	25,010	28,420
Beaver Creek	29,400	19,990
Medicine Creek	48,590	50,600
Red Willow Creek	24,400	26,240
Driftwood Creek	3,650	3,900
Frenchman River	123,060	124,350
South Fork Republican River	26,150	36,730
Rock Creek	8,870	9,960
Buffalo Creek	5,010	5,410
Arikaree River	8,900	12,230
No. Fork Republican River in Colorado	39,700	44,010
Main Stem Republican River plus Blackwood Creek	191,740	212,010
TOTAL	551,260	595,610

Source: Republican River Compact Administration.

feet sediment storage, 39,920 acre feet conservation storage, and 128,820 acre feet flood storage.

Surface Water Developments in Kansas

The USBR and Corps of Engineers (CE) have constructed three reservoirs in Kansas. The CE constructed the Milford Reservoir on the

Republican River near its confluence with the Kansas River and close to Junction City, Kansas. The main purposes of the reservoir is flood control, recreation and anticipated future municipal and industrial water needs. The total capacity is 1.16 million acre feet with 460 thousand acre feet conservation and sediment storage and 700 thousand acre feet flood control storage. The USBR has constructed the Norton Reservoir on Prairie Dog Creek near Norton, Kansas, for flood control and irrigation. The structure has total storage capacity of 134,740 acre feet with 2,720 acre feet of sediment storage, 33,220 acre feet conservation storage and 98,800 acre feet of flood control storage. Lovewell Reservoir near Lovewell, Kansas, is also a USBR structure built for flood control and irrigation. The structure has 92,150 acre feet total storage with 5,050 acre feet sediment storage, 36,640 acre feet conservation storage and 50,460 acre feet of flood control storage.

Surface Water Developments in Nebraska

The Republican River and its tributaries have also been developed extensively for surface water storage projects. The primary purpose of these developments is for irrigation, flood control, fish and wildlife, and recreation. There are five major developments that have a gross surface area of 23.8 thousand acres and gross storage of nearly 1.4 million acre feet (Table III-6). Four of these structures were constructed by the USBR, and the fifth and largest Harlan County Reservoir was constructed by the CE. The location of these major reservoirs is shown on Plate 1, General Reference Map.

There are six watersheds with structural measures built or under construction. These include one watershed developed under the pilot watershed program and five developed under the provisions of the P.L.-566 Small Watershed Program. These six projects have a combined drainage area of 513 square miles controlled by 40 floodwater structures, seven grade stabilization structures and 5.4 miles of channel modification (Table III-7).

These structures will store about 12.6 thousand acre feet of sediment and 44.8 thousand acre feet of floodwater. These structures do not store water for beneficial uses as the principal spillways will evacuate all of the floodwater detained. Consequently, they are commonly referred to as "dry" structures although there may be a minimal amount stored in borrow areas that cannot be drained. This water is commonly used by livestock and for wildlife habitat. The Watershed Project Status Map, Plate 3, shows the location of these watersheds. The Hydrologic Cataloging Unit codes for the basin are as follows: 10250001 through 10250009, 10250011, 10250014 and 10250015.

Other

At the present time, water is not imported into the basin. However, there are three areas in the basin that could benefit from out-of-basin

SWANSON LAKE
Bureau of Reclamation

RED WILLOW LAKE
Bureau of Reclamation

HARLAN COUNTY LAKE
Corps of Engineers

ENDERS RESERVOIR
Bureau of Reclamation

HARRY STRUNK LAKE
Bureau of Reclamation

TABLE III-6 SURFACE WATER STORAGE PROJECTS
Republican River Basin, Nebraska

Stream	Lake or Reservoir	Water Surface Area[1] (Acres)	Storage Capacity (Acre-Feet) Flood Control	Multiuse[2]	Total	Operating Agency[3]
Frenchman Creek	Enders Reservoir	1,707	30,040	44,480	74,520	USBR
Republican River	Swanson Lake	4,974	133,790	120,160	253,950	USBR
Medicine Creek	Harry Strunk Lake	1,768	51,690	39,230	90,920	USBR
Red Willow Creek	Hugh Butler Lake	1,628	48,850	37,780	86,630	USBR
Republican River	Harlan County Reservoir	13,700	500,000	350,000	850,000	USCE
Total		23,777	764,370	591,650	1,356,020	

1/ Water surface at top of multiuse pool.
2/ Irrigation, recreation and other multiuse functions except flood control.
3/ USBR - U.S. Bureau of Reclamation
USCE - U.S. Corps of Engineers

TABLE III-7 EXISTING PILOT AND PUBLIC LAW 566 PROJECTS
Republican River Basin, Nebraska

Watershed	Status	Watershed Drainage Area (Sq. Mi.)	Reservoirs and/or Structures: Flood Water (No.)	Grade Stabs. (No.)	Drainage Area (Sq. Mi.)	Conservation Pool 1/ (Ac.)	Total Sediment (Ac. Ft.)	Flood-water (Ac. Ft.)	Total (Ac. Ft.)	Channels (Miles)
Dry Creek - Pilot	Completed (1960)	49	- 10	7 -	18 29	2 131	4 925	- 1,690	4 2,615	0.7
Dry Creek - South	Completed (1969)	36	6	-	23	88	1,112	1,889	3,001	2.2
Stamford	Completed (1970)	4	2	-	2	18	114	201	315	2.5
Medicine Creek (Upper)	Under Construction	342	6	-	173	134	4,015	13,358	17,373	-
Medicine Creek (Lower)	Under Construction	239	3	-	116	155	3,721	9,118	12,839	-
Blackwood Creek	Under Construction	293	13	-	152	153	2,692	18,523	21,215	-

1/ Conservation pool is the lowest ungated orifice in the inlet structure.

water supplies. The first area is the Perkins-Chase County area, but also includes small portions of Hayes, Dundy and Hitchcock Counties. The second area is south and east of the existing Central Nebraska Public Power & Irrigation District (CCNPP&ID) irrigation service area. Parts of this area were originally in the CNPP&ID proposed service area, but were removed because of court decisions precluding service to them. In this case, the court prohibited water transfer from the Platte River Basin into adjoining basins. The area lies in Gosper, Phelps, Harlan, Kearney, Franklin, Adams, Webster, Nuckolls, and Thayer Counties. The third area lies entirely in the basin covering parts of Frontier, Gosper, Furnas, and Harlan Counties. All of these areas have soil highly suitable for irrigation but are lacking adequate ground water to sustain extensive development.

Surface Water Quality

The Nebraska Environmental Control Council has set criteria for parameters of water quality in the various streams and impoundments in the basin in order to protect and enhance their value for designated beneficial water uses. All surface waters shall meet general standards and shall be capable of supporting the assigned beneficial use.

Surface water quality for selected stations in the basin is monitored by the sampling program of the Nebraska Department of Environmental Control (DEC). The beneficial uses of each stream segment in the basin has been classified by the DEC. Table III-8 lists the Nebraska Water Quality Criteria and water uses for the various stream segments in the basin.

Ground Water Resources

Ground water currently supplies about 85 percent of the basin's total annual water use. Domestic requirements are wholly reliant upon ground water, while irrigation and livestock water are derived from both surface and ground water sources.

Ground Water Supply

Large supplies of ground water are generally available in much of the basin. There is an estimated 110 million acre feet of ground water in the basin's aquifers, most of which is retrievable for use. Depths to the water table range from a few feet to over 300 feet; there are also areas in the basin where supplies are inadequate or require too great a lift to be economical. These areas are generally south of the Republican River and in Webster and Nuckolls Counties (Figure III-7).

The largest quantity of ground water occurs in the sandhills, located in the western part of the basin in parts of Dundy, Chase,

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

WATERSHED PROJECT STATUS MAP

REPUBLICAN RIVER BASIN

NEBRASKA

LEGEND

- STATE BOUNDARY
- COUNTY BOUNDARY
- TOWN OVER 5,000
- TOWN 0-4,999
- DRAINAGE
- DAM AND LAKE
- U S HIGHWAY
- STATE HIGHWAY
- RAILROAD
- BASIN BOUNDARY
- SUBBASIN DRAINAGE AREA OF MORE THAN 700 SQUARE MILES
- 41a3 SUBBASIN IDENTIFICATION NUMBER (ATLAS OF RIVER BASINS, JUNE 1963)
- WATERSHED AREAS OF LESS THAN 250,000 ACRES
- (2) WATERSHED NUMBER WITHIN SUBBASIN
- NATIONAL RESOURCE DISTRICT

PILOT WATERSHEDS

- COMPLETED 41o-14

(PL 566) WATERSHEDS

- COMPLETED 41o-8, 41o5-8
- UNDER CONSTRUCTION 41o4-2, 3; 41o3-8
- FEASIBLE FOR PROJECT ACTION 41o-13, Pt.of 41o-21

NUMBER		NAME	DRAINAGE AREA (ACRES)
41a	1	Chase - Dundy Sandhills	123,900
41a	2	Indian Creek	100,000
41a	3	Burntwood Creek	67,200
41a	4	Muddy Creek (Dundy Co.)	95,100
41a	5	Culbertson to Stratton Tribs. (North)	71,500
41a	6	Culbertson to Stratton Tribs. (South)	90,300
41a	7	Driftwood Creek	131,700
41a	8	Dry Creek (South) 1/	22,800
41a	9	McCook Tribs.	52,600
41a	10	Steepy Hollow - Brushy, etc. Creeks	86,900
41a	11	Red Willow Creek (Upper)	272,000
41a	12	Red Willow Creek (Lower)	235,280
41a	13	Coon Creek	60,100
41a	14	Dry Creek (Pilot) 1/	35,100
41a	15	Cambridge to Bartley Tribs. (North)	30,400
41a	16	Silver Creek	30,100
41a	17	Republican R. South Tribs. (Furnas Co.)	111,200
41a	18	Deer Creek	126,800
41a	19	Muddy Creek (Frontier & Gosper Co.)	161,100
41a	20	Elk-Turkey etc. Creeks	205,800
41a	21	Orleans Tribs.	250,000
41a	22	Turkey Creek	106,200
41a	23	Lost Creek - etc. Tribs.	54,100
41a	24	Sacramento Tribs.	76,700
41a	25	Center - etc. Tribs.	99,100
41a	26	Thompson Creek	191,600
41a	27	Lohrl-Oak-etc. Creeks	84,800
41a	28	Farmers - Indian - etc. Creeks	77,500
41a	29	Red Cloud Tribs.	95,800
41a	30	Minnie Creek	6,500
41a	31	Coquilland Tribs.	35,000
41a	32	Superior Tribs.	106,000
41a1	8	North Fork Republican River	14,600
41a1	10	Buffalo Creek	82,100
41a1	11	Rock-Spring Creeks	150,200
41a1	12	Hay Canyon - etc. Tribs.	26,300
41a1(a)	6	Arikaree River	8,100
41a2	13	South Fork Republican River	3,300
41a3	1	Sand Creek	67,800
41a3	4	Frenchman River (Enders Reservoir)	164,400
41a3	5	Frenchman River (Wauneta Tribs.)	102,600
41a3	6	Frenchman River (Lower)	131,400
41a3	7	Upper Blackwood	99,900
41a3	8	Blackwood Creek 1/	187,700
41a3(a)	1	Venango Tribs.	39,100
41a3(a)	2	Spring Creek (Upper)	113,300
41a3(a)	3	Grant Tribs.	147,400
41a3(a)	4	Stinking Water Creek (Upper)	231,900
41a3(a)	5	Spring-Stinking Water Creeks (Lower)	146,600
41a4	1	Medicine Creek (Sandhills)	230,200
41a4	2	Medicine Creek (Upper) 1/	219,100
41a4	3	Medicine Creek (Lower) 1/	152,700
41a4	4	Medicine-Mitchell-etc. Creeks	83,500
41a5	6	Sappa Creek	17,100
41a5	7	Sappa Creek (Lower)	119,300
41a5	8	Stanford 1/	2,900
41a5(a)	6	Beaver Creek	14,300
41a5(a)	7	Beaver Creek (Lebanon)	125,600
41a5(a)	8	Beaver Creek (Beaver City)	129,400
41a6	4	Prairie Dog Creek (Lower)	40,300
		TOTAL	6,215,500

Note: Individual watersheds in this report are identified according to the "Atlas of River Basins in the United States" 1963, and the map "Watershed Projects Inventory" 1966, prepared by the United States Department of Agriculture, Soil Conservation Service. Adjustments in boundaries have been made to conform with the boundaries shown on the Department of Interior, U.S. Geologic Survey "Hydrologic Unit Map, 1974" and maps in watershed work plans.

1/ Existing Pilot and P.L. 566 Watershed Projects.

SOURCE
S.C.S. MAPS S.R.-34,519 AND S.R.-23,955 AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION

SCALE 1/800,000
0 5 10 15 20 25 30 MILES
0 5 10 15 20 25 30 35 40 45 KILOMETERS

PLATE 3

Rev. 9-15-78
S.R.-34,520

TABLE III-8 WATER USES AND WATER QUALITY CRITERIA
Republican River Basin, Nebraska

Stream Segment No.	Description	Criteria: PH Value	Dslvd. Oxygen >mg/l	Conductivity <µ mho/cm	Total Dslvd. Solids <mg/l	Ammonia as Nitrogen <mg/l W	Sp	S	F	Fecal Coliform Coli/100ml	Water Uses: Body Contact Full	Body Contact Partial	Fish and Wildlife	Agriculture	Industrial
1	Republican River from confluence of Thompson Creek to Nebraska-Kansas Border	6.5-8.5	6.0	900	600	4.5	2	1	2	1,000		X	X	X	
2	Republican River from Harlan County Dam to confluence with Thompson Creek	6.5-8.5	5.6	900	600	4.5	2	1	2	200		X	X	X	
3	Republican River from confluence of Sappa Creek to Harlan County Dam	6.5-8.5	5.6	900	600	4.5	2	1	2	200	X	X	X	X	
4	Sappa Creek upper reaches (in Nebraska) to confluence with Republican River	6.5-8.5	4.7	1,000	700	4.5	2	1	2				X	X	
5	Beaver Creek from upper reaches (in Nebraska) to confluence with Sappa Creek	6.5-8.5	4.7	1,000	600	4.5	2	1	2				X	X	
6	Republican River from confluence of Medicine Creek to confluence with Sappa Creek	6.5-8.5	6.0	900	600	4.5	2	1	2	1,000		X	X	X	
7A	Medicine Creek upper reaches to Medicine Creek Dam	6.5-8.5	7.0	500	400	4.5	2	1	2	200	X	X	X	X	
7B	Medicine Creek from Medicine Creek Dam to confluence with Republican River	6.5-8.5	6.4	500	400	4.5	2	1	2	1,000		X	X	X	

(Continued)

TABLE III-8 (Continued)

No.	Stream Segment Description	Criteria: PH Value	Dslvd. Oxygen >mg/l	Conductivity <μ mho/cm	Total Dslvd. Solids <mg/l	Ammonia as Nitrogen <mg/l: W	Sp	S	F	Fecal Coliform Coli/100ml	Water Uses: Body Contact: Full	Partial	Fish and Wildlife	Agriculture	Industrial
8	Republican River from Red Willow Creek to confluence with Medicine Creek	6.5-8.5	6.0	900	600	4.5	2	1	2	1,000		X	X	X	
9A	Red Willow Creek upper reaches to Red Willow Dam	6.5-8.5	5.6	700	525	4.5	2	1	2	200	X	X	X	X	
9B	Red Willow Creek from Red Willow Dam to confluence with Republican River	6.5-8.5	6.0	600	400	4.5	2	1	2	1,000		X	X	X	
10	Republican River from confluence of Frenchman River to confluence with Red Willow Creek	6.5-8.5	6.0	900	600	4.5	2	1	2				X	X	
11A	Frenchman River from Nebraska Colorado Border to Enders Dam	6.5-8.5	5.6	500	375	4.5	2	1	2	200	X	X	X	X	
11B	Frenchman River from Enders Dam to confluence with Republican River	6.5-8.5	6.0	675	500	4.5	2	1	2	1,000		X	X	X	
12	Republican River from South Fork of the Republican River to confluence with Frenchman River	6.5-8.5	5.6	900	600	4.5	2	1	2	200	X	X	X	X	
13	Republican River from Nebraska Colorado Border to confluence with South Fork Republican River	6.5 8.5	5.0	900	600	4.5	2	1	2				X	X	

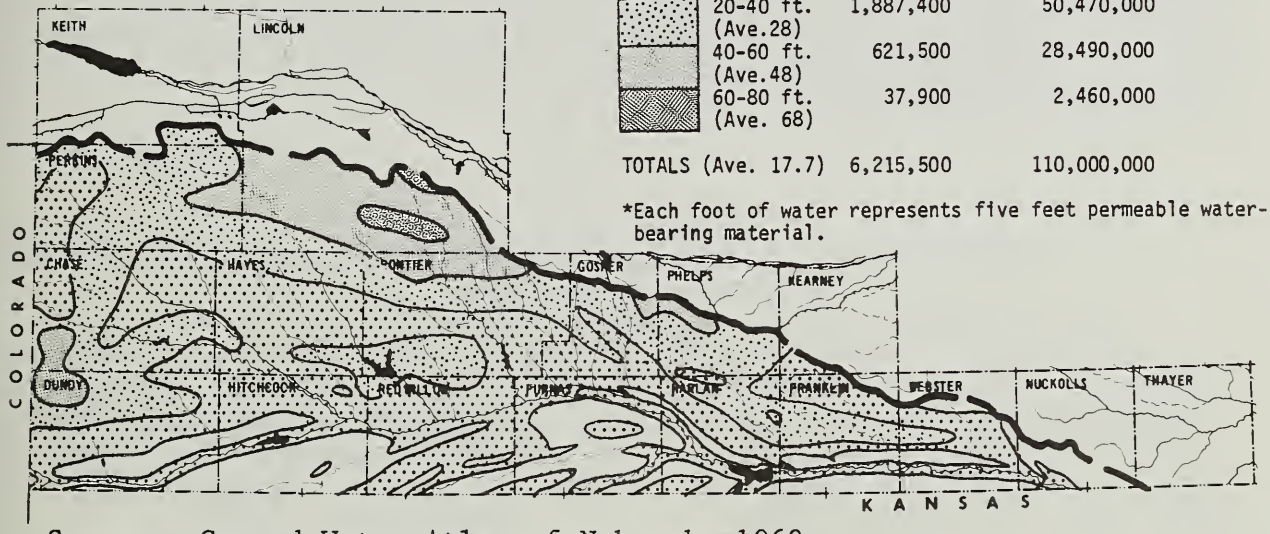
Source: Nebraska Department of Environmental Control.

FIGURE III-7
GROUND WATER IN STORAGE
Republican River Basin
Nebraska

LEGEND

Feet of Water*	Area-Acres	Acre Feet of Ground Water
0-4 ft. (Ave.1.5)	795,900	1,140,000
4-20 ft. (Ave.10)	2,872,800	27,440,000
20-40 ft. (Ave.28)	1,887,400	50,470,000
40-60 ft. (Ave.48)	621,500	28,490,000
60-80 ft. (Ave. 68)	37,900	2,460,000
TOTALS (Ave. 17.7)	6,215,500	110,000,000

*Each foot of water represents five feet permeable water-bearing material.



Source: Ground Water Atlas of Nebraska-1969
U. S. Geological Survey & Conservation Survey U of N

Perkins, Keith, and Lincoln Counties. The physical characteristics of the sandhills region are good infiltration, good quality water, shallow to moderate depth, and large to moderate supplies that support well withdrawals of above 500 gpm.

Good water bearing sand and gravel aquifers are generally located in the north and central parts of the basin. Ground water deposits in the central part of the basin have a large to moderate supply of water that usually supports wells producing in excess of 500 gpm.

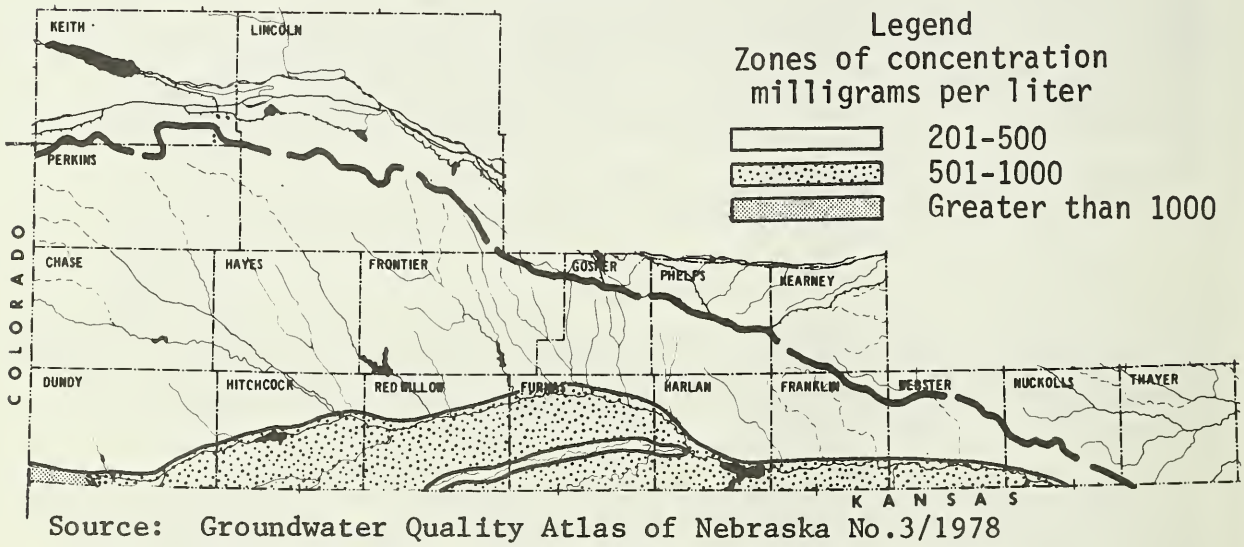
Water bearing deposits of sand, sandy gravel and sandstone are generally more limited in occurrence south of the Republican River in narrow strips adjacent to major watercourses and in the eastern part of the basin. These areas have fine grained bedrock such as shale, claystone, limestone, or chalk at or near the surface, which greatly reduces their water storage and transmission characteristics. Water supplies in these areas are small to moderate, generally producing less than 100 gpm per well.

Ground Water Quality

Ground water which occurs at comparatively shallow depths in the basin is generally of good quality for almost all uses, but is

relatively hard averaging about 400 parts per million of total dissolved solids (TDS). The western portion of the basin has the best quality ground water with that in the sandhills being about 200 parts per million TDS. Water of poorer quality occurs in some of the valleys as a result of poorer quality surface water moving in from upstream, and as a result of the concentrating of salts by evapotranspiration where the water table is shallow. Water of poorer quality usually occurs in the shale and clay where the TDS exceed 500 mg/l, some restriction on agricultural use of the water could occur depending on soils and crops grown. The general ground water quality of the basin is indicated by TDS range in Figure III-8.

FIGURE III-8
DISSOLVED SOLIDS
Republican River Basin
Nebraska



Source: Groundwater Quality Atlas of Nebraska No.3/1978
U.S. Geological Survey and Conservation & Survey
Division U of N

Relationship of Resource Base to Objectives

National Economic Development (NED)

The incidence of location, climatic factors, water, and related land resources can be utilized to further the NED objective. Careful use and management of these resources will result in increased quality and quantity of the basin's productive output. Improvements in the NED objective are measured in monetary terms as well as the costs of generating the increases. Thus, NED is enhanced when increases in output exceed the added costs to achieve the output, or when the level of

output is maintained, but production requires fewer inputs (lower cost). The latter may occur through productivity relationships of plan elements.

Environmental Quality (EQ)

In a similar manner, the location, climatic factors, water, and land resources can be utilized to further the EQ objective. Preservation, proper management, careful use, and attention to these resources will add to both the quality and quantity of land, water, wildlife, and historical and archeological resources. These activities will serve to improve the environment and as a source of present and future enjoyment for future generations.

Existing Water and Related Land Resource Projects and Programs

A variety of programs provide technical services and financial assistance to develop water and related land resources. These projects and programs are administered by a number of State and Federal agencies. Although the programs administered by these agencies are comprehensive, the present level of funding and staffing is below requirements. Discussion of these programs follows:

United States Department of Agriculture

Soil Conservation Service

The Soil Conservation Service (SCS) is the technical agency of the U.S. Department of Agriculture having the primary responsibility to assist farmers with soil and water conservation. The SCS brings together various disciplines needed to solve the on-farm land and water conservation problems and gives on-site technical assistance to individuals in preparation of conservation plans for their land. The plan outlines needed actions to conserve and develop soil, water, plant, and wildlife resources and includes a timetable for doing these. The SCS provides technical assistance for all conservation practices called for in a conservation plan, such as design, layout and supervision of construction of all mechanical practices. Assistance is also provided for conservation management type practices on cropland as well as on native range and other grasslands. Technical assistance in the development of private income producing outdoor recreation developments is also given. Guidance is provided for maintaining the measures and practices after they have been applied. The SCS administers the Great Plains Program which provides for technical assistance and cost-sharing under a long-term contract.

The landowners and/or operators are farming or ranching over 6.0 million acres of land in the basin. Six thousand two hundred and

twenty conservation plans have been prepared on 3.2 million acres. The lands in the basin that have been adequately treated total 1.9 million acres, and lands adequately protected amount to 4.9 million acres. Cumulative land treatment in the basin includes 41.9 thousand miles of terraces, 4.8 thousand acres of grassed waterways and outlets for terrace systems, 336.3 thousand acres of grass and range seeding, conversion of 30.9 thousand acres of cropland to grassland, and the conversion of 0.7 thousand acres of cropland to wildlife and recreation lands.

Incidental to its primary responsibility to assist farmers with soil and water conservation, the SCS is involved with environmental control. As a result of the reduction of soil erosion, sedimentation of streams is reduced. More directly, it is involved with feedlot design to reduce water pollution and is now actively involved with urban construction to reduce on-site erosion.

SCS provides soil maps and interpretations to local officials or planning boards, to developers and engineers and to others engaged in regional and community planning. Detailed soil surveys have been completed on approximately 5.1 million acres in the basin as of January 1, 1978.

The SCS has the overall leadership for the U.S. Department of Agriculture project activities carried out under the Watershed Protection and Flood Prevention Act (P.L. 83-566, as amended). The SCS provides assistance to sponsors in the preparation of a watershed work plan and the design and supervision of construction of structural measures. This may include measures for watershed protection, flood prevention, irrigation, drainage, water supply, public recreation, and fish and wildlife development. Six watersheds have been authorized for construction in the basin. These watersheds are: Stamford, Harlan County, 2,870 acres; Dry Creek (South), Red Willow County, 22,810 acres; Dry Creek (Pilot), Frontier and Red Willow Counties, 31,280 acres; Medicine Creek (Upper), Frontier and Lincoln Counties, 219,140 acres; Medicine Creek (Lower), Frontier and Lincoln Counties, 152,700 acres; and Blackwood Creek, Hitchcock and Hayes Counties, 187,700 acres. The total structural program in these projects includes 40 floodwater retarding structures, 7 grade stabilization structures and 5.4 miles of channel modification. Structural measures installation costs amount to $3.3 million.

The SCS is authorized to provide technical and financial assistance to local groups in conserving and developing their natural resources through Resource Conservation and Development projects. These rural-urban projects are locally initiated, sponsored and directed, and provide local groups the opportunity to coordinate and use Federal, State and local facilities to develop the natural resources for economic improvement and community betterment.

Forest Service

Cooperative State and private forestry programs are varied and cover virtually all values of the forest through assistance in forest management, protection and tree planting. Cooperative programs include fire protection; technical assistance services, forest pest, insect, and disease control; tree seeding and planting; tree seedling production; forest watershed management; forest products harvesting, processing and marketing; and urban and community forestry. The major cooperative programs are:

1. Section 2 of the Clark-McNary Act of 1924 provides authority for cooperative fire control. Under this act, the State and Federal government have joined to provide for or make available adequate fire control on nonfederal lands. The Federal government can match State and private expenditures up to 50 percent.

2. Section 4 of the Clark-McNary Act of 1924 gives the U.S. Forest Service authority to cooperate with the State in growing and distributing tree seeds and planting stock to landowners.

3. The Agricultural Act of 1956, Title IV, charges the Forest Service to assist the State in bringing into production forest land not adequately stocked with marketable tree species.

4. Cooperative Forest Management Act of 1951, as amended, provides for programs designed to give assistance to private forest owners, especially owners of small woodlands. It is the statutory authority for the urban and community forestry program. It also provides for assistance to loggers and processors of primary forest products.

5. Technical assistance is provided for the acceleration of forestry practices in P.L. 83-566 small watershed projects and other applicable programs. Forest Service research conducts research in tree improvement by means of genetic tree selection and breeding, tree windbreak management, tree disease control, and working cooperatively in tree planting and shelterbelt research with the State Experiment Stations.

Economics, Statistics, and Cooperatives Service

The Economics, Statistics, and Cooperatives Service conducts national and regional programs of research, planning and technical consultation and services pertaining to economic and institutional factors and policy which relate to the use, conservation, development,

management, and control of natural resources. This includes their extent, geographic distribution, productivity, quality, and the contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials and resource investment economics; impact of technological and economic change on the utilization of natural resources; resource income distribution and valuation; and the recreational use of resources. The agency also participates in departmental and inter-agency efforts to formulate policies, plans and programs for the use, preservation and development of natural resources.

Science and Education Administration

The Agricultural Research Service conducts research aimed at improving and maintaining production in all phases of agriculture and protecting the invaluable soil and water resources. The research program within the field of soil, water and air sciences is oriented primarily to the needs of farmers and conservationists for scientific determination of the feasibility and effectiveness of soil and water conservation practices. Research is continually pursued on both the physical requirements and the physical effects of soil and water conservation. Examples of the many studies underway are water management, including soil-water storage, crop use and improving water quality through efficient use of chemicals; sediment yield; delivery rates and nutrient losses; conservation cropping, including the chemical and microbiological aspects and residue management; management and utilization of agricultural wastes, including animal wastes; and the hydraulic characteristics of overland runoff and of surface methods of irrigation.

Extension Service

The extension Service is part of the cooperative Extension Service partnership. Federal, State and County levels of government share in financing, planning and carrying out information and educational programs. The Extension Service acts as the educational agency of the U.S. Department of Agriculture and the land grant universities. Extension specialists and County agents work with other agencies to provide local people with information relating to soil and water conservation programs plus other types of information and assistance. This work has been an integral part of USDA since 1914, when the Smith-Lever Act became law.

Farmers Home Administration

The Farmers Home Administration channels credit to farmers, rural residents and communities. It helps borrowers gain maximum benefit from loans through counseling and technical assistance. Farmers

have several credit programs they can call upon through the Farmers Home Administration to help purchase, expand, improve, and operate farms. Credit is also available to construct, acquire and improve service buildings and dwellings for self and hired labor. Some loan programs are strictly for individuals and their families, others involve associations, partnerships, corporations, and public bodies.

Individual housing loans are available to buy, build, improve, or relocate homes. In addition, the Farmers Home Administration makes loans in rural areas to provide rental housing for persons with low or moderate income and for persons age 62 or older. Credit is available to local organizations to construct, enlarge, extend or improve water, sewer and solid waste disposal systems and other community facilities that provide essential services to rural residents and to pay necessary costs connected with such facilities.

The Farmers Home Administration gives financial assistance to towns and cities to help with water and waste disposal systems. This assistance is in the form of loans and grants. Loans must be repaid by the towns, but grants are gifts-in-aid and need not be repaid. The 1978 Nebraska Community Programs Progress Report gives the status of aid to towns through 1978.

In the Republican Basin, assistance has been given to the following seven towns: Atlanta, Beaver City, Culbertson, Haigler, Indianola, Superior, and Trenton. Grants amount to $412,900, and loans amount to $1,151,000.

Agricultural Stabilization and Conservation Service

The Agricultural Stabilization and Conservation Service administers the USDA Agricultural Farm Program relating to agriculture production control. It also administers the Agriculture Commodity Storage and Loan Program and the Waterbank Program. Cost sharing for installing conservation practices is provided by the Agricultural Stabilization and Conservation Service under an annual program, long term agreement program, and in emergencies caused by a natural disaster.

Department of the Army

Corps of Engineers

The Corps of Engineers (Corps) has general responsibility for planning, constructing and improving harbors, dredging navigable streams, and maintaining navigable channels; planning and constructing flood control and multipurpose projects; controlling hydraulic-mining debris; administering laws pertaining to the protection and preservation of navigable waters; fighting floods and making emergency repairs; and

making investigations and engineering reports on stream basins, harbors and shorelines. Reservoirs constructed may also include storage space for future domestic, municipal and industrial needs and for regulation of streamflow for the purpose of water quality control.

The Corps has installed one major multipurpose reservoir in the Nebraska portion of the Republican River Basin. Storage provided by the Harlan County Dam includes capacity for flood control, irrigation, recreation, as well as for conservation and sedimentation. The reservoir formed by Harlan County Dam has a storage capacity of 850 thousand acre feet including the space for the storage of 500 thousand acre feet of floodwater. A total of 350 thousand acre feet of space has been provided for irrigation, conservation and sedimentation. The water impounded for these purposes creates a lake of 13,700 acres, having a shoreline of 75 miles. The reservoir would cover 22,790 acres if it were filled to the top of the gates.

The Corps has also constructed two local protection projects in the basin providing flood protection to the towns of Indianola and Bartley, Nebraska. Indianola, Nebraska, is located on the Republican River and Coon Creek in Red Willow County. The project consists of levees and channel improvement built in 1949. Bartley, Nebraska, is located on the Republican River and Dry Creek in Red Willow County. The project consists of levees and channel improvement built in 1952.

Department of the Interior

Bureau of Reclamation

The Bureau of Reclamation (BR) plans and constructs measures for irrigation, power generation, municipal and industrial uses, recreation, fish and wildlife enhancement, stream regulation, and pollution control. The BR also works with the Corps in developing programs for navigation and flood control.

Various Federal acts have assigned the BR the following powers: (1) to provide for project water for land tracts of 160 irrigable acres; (2) to sell reclamation project water to non-project users; (3) to use project revenues for the reduction of project costs; (4) to sell electricity generated by reclamation projects; (5) to provide and contract for water for municipal purposes; (6) to sell power and use of irrigation water on multipurpose projects constructed by the Corps.

The BR constructed and operates Enders, Swanson, Hugh Butler, and Harry Strunk Lakes and Reservoirs. Operating instructions are furnished by the Corps when the reservoir water surface is in the flood control pool. There is a total of 764,370 acre feet of flood control storage available in the structures designed to contain a flood equal to that of the flood of May-June, 1935.

A total of 591,650 acre feet of multiuse (irrigation) storage is available in these structures and in the Harlan County Reservoir. The projects provide irrigation service for 88,887 acres of land in Nebraska. However, the amount of land irrigated varies from year to year with available water supply.

U.S. Fish and Wildlife Service

The basic objectives of the Fish and Wildlife Service (FWS), as stated in the Department of the Interior Manual, are to assist in the development and application of an environmental stewardship ethic for our society, based on ecological principles, scientific knowledge of fish and wildlife and a sense of moral responsibility; the FWS assists and guides the conservation, development and management of the nation's fish and wildlife resources and assists in the development of a national program to provide the American public opportunities to understand, appreciate and use fish and wildlife resources. These objectives support the FWS mission of assuring maximum opportunity for the American people consistent with their needs and desires, to benefit from fish and wildlife resources as part of man's natural environment.

U.S. Geological Survey

The Geological Survey's broad mission is to enlarge the knowledge of the extent, distribution, character, and origins of the nation's natural resources and of the geologic processes that affect the use of them. It collects, analyzes and publishes detailed information about the nation's mineral, land and water resources. Included in its responsibilities are topographic mapping, chemical and physical research, stream gaging and water-supply assessment, and supervision of mineral exploration and development activities on Federal and Indian lands. Much of its work in Nebraska is done in close cooperation with other Federal agencies and with State and local agencies.

Heritage, Conservation and Recreation Service

The Heritage, Conservation and Recreation Service (HCRS) coordinates a broad range of conservation and recreation activities by citizens in the public and private sectors. HCRS forms the nucleus of the National Heritage Program, a process of identifying, evaluating and protecting our cultural and natural resources, and serves as the focal point for assuring adequate recreation opportunities. To fulfill its responsibilities in each of these areas, HCRS incorporates the functions of the Office of Archeology and Historic Preservation (OAHP) and the National Landmarks Program. HCRS also administers the Land and Water Conservation Fund for acquiring land for Federally administered recreation areas and provides matching grants to States for the planning, acquisition and development of recreation areas and facilities; assists in

the transfer of surplus Federal property to State and local governments for public parks and recreation use; has responsibility for the recreational, historical, archeological, and natural scenic aspects of regional or river basin planning to ensure that plans of the Federal Government requiring a Federal action, license or permit give adequate consideration to these aspects; and identifies rivers and trails to be studied as potential components of the National Wild and Scenic Rivers System and the National Trails System.

National Park Service

The National Park Service (NPS) administers national parks, monuments, historic sites and recreation areas. Sufficient water is reserved to carry out the purposes for which these lands were set aside. One of the functions of the NPS is to review proposals by the Corps, the Soil Conservation Service and other Federal agencies in order to determine what effects these projects would have upon the National Park System.

Environmental Protection Agency

The Environmental Protection Agency (EPA) cooperates with Federal, interstate and State agencies, and municipalities and industries in developing comprehensive programs to improve water and air quality. EPA activities include: (1) administration of Federal grants to State and interstate water quality control and pollution agencies; (2) grants to municipalities for waste treatment works construction; (3) grants for research, development, water pollution control, and nonpoint pollution programs; (4) development and application of water quality control standards for streams; (5) interstate pollution surveillance; (6) training of pollution control personnel and technical assistance to States and localities; (7) establishment of field and research laboratories to develop water quality control techniques and to train personnel; (8) dissemination of public information on water quality and pollution control; (9) establishment and enforcement of regulatory programs; (10) control of pollution for Federal installations; (11) control of oil pollution in navigable waters; (12) pesticides research, standard setting and registration; (13) review of proposed actions subject to the National Environmental Policy Act (P.L. 91-190) of 1970; (14) Administration of the Safe Drinking Water Act; (15) Administration of Toxic Substances Act; (16) Administration of the Clean Air Act; (17) Administration of the Solid Waste Disposal Act; and (19) Administration of the Clean Water Act.

Department of Housing and Urban Development

The Department of Housing and Urban Development (HUD) is empowered to make grants to local bodies of government for the purpose of

comprehensive planning--including planning for water supply, sewer facilities and storm drainage. Through HUD, both grants and public facility loans are available to local public bodies and agencies to provide water and sewer facilities. The grants are dependent upon a showing that the projects are consistent with area-wide water and sewer facilities systems as part of the area's development.

HUD is also authorized to establish and carry out a flood insurance program. The National Flood Insurance Program has two main thrusts: (a) it encourages States and communities wishing to participate to make appropriate land use adjustments designed to prevent unwise use of the flood plain and reduce the amount of property exposure to flood, and (b) through a cooperative effort between the Federal Government and the private property insurance industry, it provides insurance protection against flood losses to owners of properties in flood-prone areas who previously were unable to obtain insurance, and for owners of properties already in the flood plain, the program provides Federal assistance to keep rates within reasonable bounds.

The following is a list of communities and unincorporated areas participating in the National Flood Insurance Program in the basin.

Participating Communities

Community	County
Cambridge	Furnas
Culbertson	Hitchcock
Franklin	Franklin
Holdrege	Phelps
Indianola	Red Willow
Madrid	Perkins
Red Cloud	Webster
Stratton	Hitchcock
Superior	Nuckolls
Trenton	Hitchcock
Venango	Perkins
Wauneta	Chase
Webster County (Unincorporated)	Webster

Communities in the basin have been notified of their tentative identification as having one or more areas of special flood hazard, but they are not participating in the National Flood Insurance Program. Effective July 1, 1975, or one year after a communities' identification, whichever is later, no Federal or Federally-related financial assistance can legally be provided for acquisition or construction in an identified special flood hazard area of a community which is not participating in the program. This prohibition does not apply to any loan made by a Federally-supervised, approved, insured, or regulated lending institution made prior to March 1, 1976, to finance the acquisition of a previously occupied residential dwelling.

The following is a list of those communities with special flood hazard tentatively identified but not in the program:

Areas Which Have Had Special Flood Hazards
Identified Not in the Program

Community	County
Arapahoe	Furnas
Beaver City	Furnas
Curtis	Frontier
Guide Rock	Webster
Haigler	Dundy
Hardy	Nuckolls
Hildreth	Franklin
Holbrook	Furnas
Maywood	Frontier
McCook	Red Willow
Naponee	Franklin
Orleans	Harlan
Palisade	Hayes & Hitchcock
Riverton	Franklin
Wilcox	Kearney
Wilsonville	Furnas

Department of Commerce

National Weather Service

The National Weather Service (NWS) provides flood forecast service for major river basins in Nebraska. The NWS involves the prediction of stage at a particular gage or gages based on observed precipitation, flows at upstream points, reservoir operation and release schedules, and anticipated weather conditions. The forecast for floods are then transmitted to municipal officials, newspapers,and radio and TV stations in the area for dissemination to occupants of the flood plain. This allows the public and individuals in the lowlands to take protective measures.

Flash flood information is based on data developed by the Grand Island Weather Service Office which is equipped with radar. The contributing area above Franklin and below Harlan County Dam is within range for application of radar to flash flood warning. Major flood forecasts are based on radar observations, immediate reports from the Republican Basin rainfall and river gage networks and the reservoir regulation reports. Forecast crest stages for the Republican River based on observed rain can usually be provided with a lead time of 6 to 12 hours from the heavy rainfall.

State of Nebraska

Natural Resources Commission

The Natural Resources Commission (NRC) serves as the official agency of the State in connection with soil and water conservation, flood prevention, watershed protection, flood plain regulation, flood control, and development of the Nebraska Water Planning and Review Process. Current duties and authorities can be categorized into three areas: (1) assistance to local subdivisions of government; (2) flood plain management; and (3) water planning.

The NRC provides assistance to local subdivisions of government, such as the Natural Resources Districts, with primary local authority for land and water conservation. Financial aid can be provided to local subdivisions through the Small Watershed Flood Control Fund. Financial aid is also provided by the Nebraska Resources Development Fund, which can be utilized by any State agency or political subdivision with authority to develop the water or related land resources of the State.

The NRC is responsible for the administration of Nebraska's flood plain regulation act and State coordination of the Federal flood insurance program. The NRC has been assigned several planning activites including the legislatively assigned task of developing the Nebraska Water Planning and Review Process. The NRC prepares water quality plans and administers a natural resources data bank.

Department of Health

Responsibilities of the Department of Health (DH) in water resources management include environmental sanitation programs and inspection of and evaluation of public and private water supplies. The DH administers the Safe Drinking Water Act which covers public water supply and distribution systems serving 25 or more consumers. The DH also conducts mosquito and other water related vector surveys and recommends remedial actions.

Department of Water Resources

The Department of Water Resources (DWR) has original jurisdiction over matters pertaining to rights to the use of water in all natural streams in the State for irrigation, power and other useful purposes. It also regulates the use of water from natural streams in accordance with the rights. The DWR approves all plans for proposed drainage districts, conducts public hearings concerning rights to the use of waters of the State and examines and approves plans of all proposed dams to be constructed for reservoir purposes or across the channels of natural streams. It approves the petitions for formation of irrigation

and reclamation districts, and registers water wells used for irrigation, municipal and manufacturing purposes, and issues permits relative to the spacing of water wells, when applicable.

Game and Parks Commission

The Game and Parks Commission (GPC) has sole charge of State parks, fish and wildlife, recreation grounds, and all related things. Included in their power and duties is the stocking of game and fish in the State; the establishment, operation and management of State parks, hatcheries, recreation grounds, game farms, wildlife refuges, and public hunting areas; and administration of the Land and Water Conservation Fund, (P.L. 88-578); setting season and bag limits; and enforcing fish and game laws.

Department of Environmental Control

The Department of Environmental Control (DEC) has general supervision over the prevention, abatement and control of all water, land and air pollution, including agricultural wastes. Responsibilities include the enforcement of all rules and regulations; development of comprehensive programs; administration of grants and loans from the Federal government and other sources; and the development and adoption of air, water and land pollution control standards.

State Office of Planning and Programming

The State Office of Planning and Programming (SOPP) has been given the principal duty of planning the comprehensive development of the social, economic and physical resources of the State and coordinating the programs of the State and its subdivisions required to put such comprehensive development plans into effect. To aid in the compliance with these directives, the Governor may require any of the State's departments, agencies or institutions to furnish the Office with information, personnel, equipment, and services.

University of Nebraska

Conservation and Survey Division

The Conservation and Survey Division (CSD) is authorized to survey the State's soils, water and water power, geology, forests, road materials, and industry. To carry out its functions in these areas, the CSD has the following duties: (1) survey and describe the natural resources in the State; (2) study the climate, physical features, geology, and mineral resources in the State; (3) study and describe the

operations, production and importance of leading industries; (4) investigate and report on the State's conservation problems; (5) study water-bearing formations and assist in the location of water supplies; (6) secure and preserve logs and physical data of wells drilled; (7) prepare and present publicity and educational materials on the State's resources, industries, institutions,and development; (8) investigate and report misrepresented or fraudulent sales and offers for sale of foreign realty, oil, mineral, and gas structures and leases or interest in them; and (9) provide an information bureau on the State's resources, undustries and development. The CSD may also enter into agreements with Federal agencies necessary to carry on cooperative surveys and investigations. Presently, soil surveys are being conducted in cooperation with the U.S. Department of Agriculture, and the water surveys are being conducted in cooperation with the U.S. Geological Survey.

Institute of Agriculture and Natural Resources

The Institute of Agriculture and Natural Resources (IANR) conducts research in use and management of water resources, watershed protection, and soil and water conservation, and conducts surveys of soil, mineral and water resources. It provides information to the people of Nebraska on the natural resources of the State, protection of the environment, reduction of soil erosion, and development of the natural resources for economic improvement and community betterment. It furnishes data and interpretations to consultants, planning boards, developers, engineers, and others engaged in regional and community planning and development.

Agricultural Experiment Station

The Agricultural Experiment Station (AES) conducts research and experiments on the physiology of plants and animals, diseases of plants and animals and their remedies, chemical compositions and patterns of growth of useful plants, production systems for plants and animals, capacity of new plants for acclimation, soil fertility, soil conservation and management, water development and utilization, chemical control of pests, adaptation and value of grasses and forage plants, composition and digestibility of animal foods, marketing products, human nutrition, product processing, rural families and homes, and any other experiements bearing directly upon the agricultural industry and rural life.

Bulletins and reports of the activities and experiments conducted are published regularly and are provided to the public upon request, so far as possible.

Cooperative Extension Service

The Cooperative Extension Service (CES) is a cooperative service partnership including the Federal, State and County governments, each of which share in financing, planning and carrying out of extension education programs. Information provided through the program is obtained through research at the several State experiment stations, Federal U.S.D.A. laboratories and observations by specialists in the field. It is disseminated through farm and home visits, public meetings, study workshops, demonstrations, radio, newspapers, television, circulars, and bulletins. The CES provides numerous bulletins and circulars, many of which have special significance to the State's waters.

Department of Forestry, Fisheries and Wildlife

The Department of Forestry, Fisheries and Wildlife (DFFW) provides assistance in a wide variety of cooperative programs with public entities, organizations and individuals.

Local Districts

Natural Resources Districts

In 1969, the Legislature directed that existing soil and water conservation districts, watershed conservancy districts, watershed districts, advisory watershed improvement boards, and watershed planning boards, having limited individual reponsibilities, be reorganized into larger, more comprehensive Natural Resources Districts (NRDs). The new districts are provided with the consolidated powers and programs of the merged districts, some additional authorities and new boundaries more relevant to comprehensive natural resources development problems of Nebraska.

These NRDs have an array of project authorities available to local people in solving local resource problems. These authorities related to soil and water resources include: (1) erosion prevention and control; (2) prevention of damages from floodwater and sediment; (3) flood prevention and control; (4) soil conservation; (5) water supply for any beneficial use; (6) development, management, utilization, and conservation of ground water and surface water; (7) pollution control; (8) solid waste disposal and sanitary drainage; (9) drainage improvement and channel rectification; (10) development and management of fish and wildlife habitat; (11) development and management of recreational and park facilities; and (12) forestry and range management.

Basically, all of the study area lies within four NRDs, which are legal entities of government of the State of Nebraska. These are the Upper Republican, Middle Republican, Lower Republican, and the Tri-Basin

NRDs, whose headquarters are respectively located in Imperial, Curtis, Alma, and Holdrege. Small areas lie in the Little Blue and Twin Platte NRDs with headquarters in Davenport and North Platte, respectively.

In addition to sponsoring a land treatment program, the NRDs have been active in sponsoring water and related land projects. Some of the projects have been in cooperation with the USDA while other projects have been implemented in cooperation with the University of Nebraska Conservation Survey Division and/or the Nebraska Natural Resources Commission (NRC) Development Fund and staff. In some cases, either the County and/or cities have also been joint sponsors. In the Upper Republican NRD, a ground water study, sponsored by the district, has been completed. A flood control project consisting of three floodwater retarding structures and a small levee to protect the town of Wauneta is in the planning stage. This project will be built by funds from the NRD, city of Wauneta, Chase County, and a grant from the NRC Development Fund. A ground water control project has been established for the areas north of the Republican River which requires flowmeters to be installed on irrigation wells by 1980. It also provides that by 1985, new irrigation wells must be at least 1,320 feet from domestic or livestock wells and 3,300 feet from other irrigation wells in the townships that have been designated "critical".

The Middle Republican Natural Resources District has sponsored one pilot and four P.L. 566 watersheds located in the district. These include the Dry Creek (pilot), Dry Creek (South), Upper and Lower Medicine Creek, and Blackwood Creek. All are authorized for construction. These projects call for a total of 47 grade stabilization or floodwater retarding structures of which 23 have either been built or are under construction. In addition, the district, along with the Natural Resource Commission Development Fund, city of McCook and Red Willow County, expects to fund the construction of two floodwater retarding structures on Kelly Creek. The Middle Republican and Twin Platte NRDs cooperated with the Conservation Survey Division, University of Nebraska, and the U.S. Geological Survey in a ground water study for the area north of the Republican and south of the Platte River in Lincoln, Frontier, Hayes, Hitchcock, and Red Willow Counties. A special wildlife program of 1,700 acres is also sponsored by the NRD.

The Lower Republican Natural Resource District sponsored the installed P.L. 566 project on the Stamford Watershed. This project consisted of two floodwater structures and one levee. There have been several structures installed by this NRD with the assistance from the NRC Development Fund. This includes two road structures and one grade stabilization structure in the Milrose Watershed. They have also cooperated with the County on four other combination road structures which provide grade stabilization and associated flood control benefits. This district also has a wildlife program covering some 1,700 acres. Land is leased to control grazing, and some additional plantings have been made to preserve and enhance wildlife habitat. Flowmeters and technical assistance have been provided for irrigation scheduling so that improved water management might be achieved.

Reclamation Districts

The purposes of reclamation districts are to control and make use of the available waters of the State for domestic, irrigation, drainage, power, manufacturing, recreation, and other beneficial purposes. A reclamation district has the power to acquire and use water rights, waterworks, and real and personal property for carrying out its powers; to condemn under the right of eminent domain; to enter into contracts with the United States relating to the waterworks; to list in separate ownership the lands within the district susceptible of irrigation from the district's sources and to enter into contracts to provide water service to these lands; to fix rates for water service; to borrow money; and to levy and collect taxes and special assessments.

Ground Water Conservation Districts

Ground water conservation districts have the power and duty to maintain an office and employees as necessary; to gather information on ground water conservation and supply it to the Department of Water Resources, the Conservation and Survey Division of the University of Nebraska, and the Nebraska NRC as requested; to enter into contracts; and to adopt rules and regulations to ensure the proper conservation of ground water. One ground water conservation district has been established in Chase County.

Sanitary and Improvement Districts

Sanitary and improvement districts are organized to function in the areas of flood control, channel rectification, drainage, sewage disposal, and flood plain zoning. The district has the additional power to provide for the drainage of the district with channels, drains or ditches for carrying off and disposing of drainage and sewage, and to straighten, widen or deepen any existing channel for the purpose. Sanitary and improvement districts have responsibilities for drainage, recreation, water supply, and sewage disposal.

Irrigation Districts

Irrigation districts are organized to finance water supplies, consolidate irrigation systems, construct irrigation systems or provide for drainage of irrigated land. Districts may also be formed to provide for new development or to extend and improve existing irrigation systems and works. These districts also have responsibilities in the areas of drainage, water supply, irrigation, and hydroelectric power. Irrigation districts have the power to condemn by eminent domain; to enter into contracts with the United States for construction, operation and maintenance of irrigation works; to equalize and levy assessments within the

district; to levy taxes; to issue bonds; to call special elections; to authorize special assessments; and to borrow additional funds if needed.

In the Republican Basin, the diversion dams, canals, laterals, and drains of the Frenchman-Cambridge and Bostwick Division Projects are operated and maintained by five irrigation districts. Four of the districts are located in Nebraska and one in Kansas. The four Nebraska districts are the Frenchman Valley Irrigation District, Hitchcock and Red Willow Irrigation District, Frenchman-Cambridge Irrigation District, and the Bostwick Irrigation District in Nebraska. Table III-9 shows each district and the canals and acres with service available for each canal.

TABLE III-9 IRRIGATED LANDS SERVICED BY DISTRICTS
Republican River Basin, Nebraska

District and Canal	Acres With Service Available
Frenchman Valley Irrigation District	
Culbertson Canal	9,600
Hitchcock and Red Willow Irrigation District	
Culbertson Extension Canal	11,500
Frenchman-Cambridge Irrigation District	
Meeker-Driftwood Canal	16,476
Bartley Canal	6,539
Red Willow Canal	4,932
Cambridge Canal	17,053
Total Frenchman-Cambridge	45,000
Bostwick Irrigation District	
Franklin Canal	11,116
Naponee	1,737
Franklin Pump Canal	2,091
Superior Canal	5,863
Courtland Canal (Nebraska)	1,980
Total Bostwick (Nebraska)	22,787
Total Irrigation Districts	88,887

Republican River Compact

After negotiations by Commissioners appointed by Governors of the States of Kansas, Nebraska and Colorado, and participated in by a duly appointed Representative of the United States of America, the Commissioners signed, and the Representative of the United States of America

approved, the Republican River Compact on December 31, 1942. It was ratified by the State of Colorado by an Act effective on March 15, 1943; by the State of Kansas by an Act effective on June 28, 1943; and by the State of Nebraska by an Act effective on February 24, 1943. The Compact was approved by the Congress of the United States in an Act effective on May 26, 1943 (Public Law 60, 78th Congress, Chapter 104, 1st Session).

Article IX of the Republican River Compact provides for the administration of the Compact as follows:

Article IX

> It shall be the duty of the three States to administer this compact through the official in each state who is now or may hereafter be charged with the duty of administering the public water supplies, and to collect and correlate through such officials the data necessary for the proper administration of the provisions of this compact. Such officials may, by unanimous action, adopt rules and regulations consistent with the provisions of this compact.
>
> The United States Geological Survey, or whatever federal agency may succeed to the functions and duties of that agency, in so far as this compact is concerned, shall collaborate with the officials of the States charged with the administration of this compact in the execution of the duty of such officials in the collection, correlation, and publication of water facts necessary for the proper administration of this compact.

Although the Republican River Compact became effective on May 26, 1943, it was not until July 15, 1959 that the officials responsible for its administration established a formal organization for that purpose, designating it the Republican River Compact Administration. On November 19, 1959, following consultation with representatives of several Federal and State agencies interested in the collection of hydrologic data and the development and use of the water resource of the Republican River Basin, the Administration established a "Committee on Procedures for Computation of Annual Virgin Water Supply," consisting of one representative of each of the official members of the Administration, and invited the U.S. Geological Survey, the BR, the USDA, and the Corps to cooperate with the Committee.

The Administration also formed an Engineering Committee whose duties include computation of each years annual virgin water, annual consumptive use, adjusted allocation on annual supply, five-year average and ten-year average base, and any other special assignments as deemed necessary. The Committee's results on the annual virgin water supply and compact agreement on allocations are shown on Table III-10.

TABLE III-10 REPUBLICAN RIVER COMPACT AGREEMENT
Republican River Basin - Nebraska, Colorado and Kansas

Drainage Basin	State	Computed Virgin Water Supply	Allocation
		(Acre Feet)	
Prairie Dog Creek		27,600	
	Kansas		12,600
	Nebraska		2,100
	Unallocated		12,900
Sappa Creek		21,400	
	Kansas		8,800
	Nebraska		8,800
	Unallocated		3,800
Beaver Creek		16,500	
	Colorado		3,300
	Kansas		6,400
	Nebraska		6,700
	Unallocated		100
Red Willow Creek		21,900	
	Nebraska		4,200
	Unallocated		17,700
Driftwood Creek		7,300	
	Kansas		500
	Nebraska		1,200
	Unallocated		5,600
Frenchman River		98,500	
	Nebraska		52,800
	Unallocated		45,700
So. Fork Republican River		57,200	
	Colorado		25,400
	Kansas		23,000
	Nebraska		800
	Unallocated		8,000
Rock Creek		11,000	
	Nebraska		4,400
	Unallocated		6,600
Buffalo Creek		7,890	
	Nebraska		2,600
	Unallocated		5,290
Arikaree River		19,610	
	Colorado		15,400
	Kansas		1,000
	Nebraska		3,300
	Unallocated		-90

(Continued)

TABLE III-10 (Continued)

Drainage Basin	State	Computed Virgin Water Supply	Allocation
		(Acre Feet)	
North Fork Republican River		44,700	
	Colorado		10,000
	Nebraska		11,000
	Unallocated		23,700
Mainstem of the Republican River plus Blackwood Creek		94,500	
Unallocated from tributaries other than Blackwood		175,500	
	Kansas		138,000
	Nebraska		132,000
	Unallocated		0
Total		478,900[1/]	
	Colorado		54,100
	Kansas		190,300
	Nebraska		234,500
	Unallocated		0

1/ This average value was computed in 1940, effected by the drought of the 1930's. In recent years the average water supply as shown in Table III-10 has been in excess of 500,000 acre feet.

CHAPTER IV
ECONOMIC AND ENVIRONMENTAL RESOURCES

History

Settlement in the Republican River Basin followed colonization in the eastern half of Nebraska. Prior to 1870, the region had little contact with the white man since it lay outside the main immigration routes. Trappers and traders visited the region but generally moved on to more profitable fields. The Indians, driven out of other valleys on the Plains, stubbornly resisted white efforts to penetrate this last haven where buffalo and other wild game were still plentiful.

Passage of the Homestead Act in 1862 enhanced settlement by making it possible for participants to acquire a specific piece of property through their own labor. In 1870, exploratory and settlement expeditions were organized in a number of the Missouri River towns to go out into the Republican Valley.1/ The early 1870's saw a marked extension of population into the basin valleys; among those who established the first permanent settlement in the valley at Red Cloud was Silas Garber who later served as governor of the State from 1875 to 1879. Several other towns were organized shortly thereafter by various land companies. One of these, The Republican Valley Land Company, was responsible for establishing several of the towns remaining today as well as some that failed. Nearly all of the basin counties were established by 1875, although few had existed several years earlier.

"The prospect of a railroad in the valley provided a significant impetus to settlement of the region. This prospect did not materialize until the Burlington built along the river in 1878-1882 ..."2/ Not only did the railroad promote settlement of the area, it provided a means of transport for those willing to pioneer as well as hauling their produce to other areas. Lands deeded directly to the railroad were also sold to settlers.

Economic Activity

Population and Significant Population Characteristics

The total population of the basin in April, 1970, was estimated at 66,366 (Table IV-1). This basin, like most rural areas in the U.S., had

1/ Olson, James C., History of Nebraska, Second Edition, University of Nebraska Press, p. 171.
2/ Ibid, p. 172.

TABLE IV-1 POPULATION, SELECTED YEARS
Republican River Basin, Nebraska

County	1950	1960	1970	1975 1/
	(Number)			
Chase	5,176	4,317	4,129	4,400
Dundy	4,354	3,570	2,926	2,800
Franklin	7,096	5,449	4,098	4,039
Frontier	5,282	4,311	3,488	3,416
Furnas	9,835	7,711	6,897	7,000
Gosper	2,734	2,489	1,785	1,885
Harlan	7,189	5,081	4,357	4,400
Hayes	2,404	1,919	1,530	1,500
Hitchcock	5,867	4,829	4,051	4,200
Kearney	864	844	670	690
Lincoln	1,911	1,669	1,332	1,330
Nuckolls	5,228	4,528	4,156	3,873
Perkins	4,809	4,189	3,080	2,969
Phelps	6,450	7,319	7,445	7,715
Red Willow	12,977	12,940	12,191	12,700
Webster	5,184	4,248	4,231	3,920
Basin Total	86,910	75,415	66,366	66,837
Basin as % of State	6.55	5.34	4.48	4.30
	(Percent)			
Place of Residence				
Urban	18.1	22.4	25.2	N.A.
Rural Nonfarm	38.6	38.4	42.4	N.A.
Rural Farm	43.3	39.2	32.4	N.A.

Source: U.S. Census of Population Reports.
1/ Preliminary.

a rather rapid decline in population between 1950 and 1970. However, the 1975 population estimate is slightly higher than 1970 which may be an indicator that the number of inhabitants in the basin may be stabilizing.

A decline in the rural farm population is the principal factor that has resulted in fewer residents. Rural nonfarm population also decreased slightly during the 20-year period while the number of urban residents increased; however, the increase was not large enough to offset the rural losses. There are only three urban areas with a population of 2,500 people or more within the basin. They and their 1970 populations are: McCook (8,285), Holdrege (5,635), and Superior (2,779). Therefore, population density is very low. For the basin as a whole, the average is less than seven people per square mile. Comparable measures of population density are 11 persons per square mile for Nebraska and 20 persons for the nation.

During the two decades prior to 1970, there was a net outmigration of over 31,000 people from the basin as a result of the number of people moving out of an area exceeding those moving in plus an allowance for births and deaths (Table IV-2). The rate of net outmigration for the basin is more than double the rate for the entire State of Nebraska.

TABLE IV-2 NET MIGRATION OF THE POPULATION, 1950-1970
Republican River Basin, Nebraska

Area	1950-1960		1960-1970	
	Number	Percent	Number	Percent
Republican Basin	- 21,076	-21.8	-10,170	-13.3
State of Nebraska	-116,930	- 7.7	-72,740	- 5.2

Source: (1) Net Migration of the Population, 1950-1960, By Age, Sex and Color. Volume I, Part 2, May 1965, Economics, Statistics and Cooperatives Service, USDA. (2) Population Change and Net Migration by Counties in the Great Plains States, 1960-1970. Great Plains Agricultural Council Report No. 52.

The median age of basin residents in 1970 is about 37 years as compared to 28.6 years for all residents in Nebraska. Median age for rural residents in the State is 32.6 years. This suggests that the outmigration occurring during the 50's and 60's resulted in a heavy drain upon the younger adult population. This condition has a compounding effect because a larger share of the women leaving the area are of childbearing age which can affect the size of future population. About 55 percent of the basin population is in the prime working age group, 16 to 64 years old, as compared to 57 percent for the State.

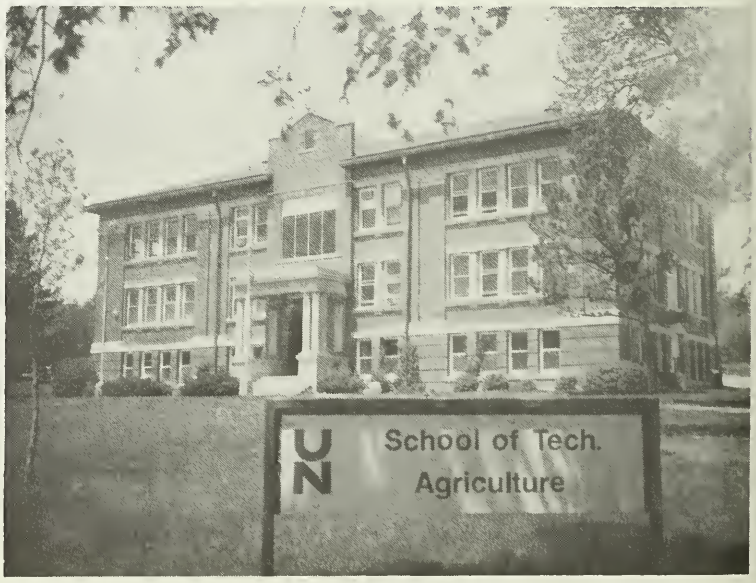
Educational levels of basin residents are similar to that for the entire State (Table IV-3). About 55 percent of the residents that are

TABLE IV-3 SELECTED EDUCATIONAL CHARACTERISTICS IN 1970
Republican River Basin, Nebraska

Item	Unit	Basin	State of Nebraska	United States
All Persons Age 25 or More:				
Less Than 1 Year of High School	Pct.	6.9	8.0	27.8
High School Graduate	Pct.	54.8	59.2	52.3
College Graduate	Pct.	6.4	9.6	10.7
Median Years of School	Yrs.	12.1	12.2	12.1
All Persons 18-24 Years Old:				
High School Graduate	Pct.	65.6	73.7	66.5
College Graduate	Pct.	5.6	6.4	6.2

Source: U.S. Department of Labor, Manpower Administration. Summaries of the 1970 U.S. Census of Population and U.S. Census of Population, 1970.

McCook Community College



Curtis-School of Technical Agriculture

25 years of age or older have completed high school as compared to about 60 percent for the entire State. The median number of school years completed is slightly over 12 years for both areas and slightly over six percent of the population is college graduates. The number of years of formal education does not always reflect how well workers are trained to perform their jobs. Also, not all occupations require the same amount as well as type of instruction. In recent years, there has been added emphasis on vocational training in lieu of formal college instruction. There are several vocational and technical schools located in or near the basin. McCook and North Platte have campuses that are a part of the Mid-Plains Technical Community College area. Curtis has a technical school that is a part of the University of Nebraska system.

Population Projections

Future population growth of an area is a function of characteristics of the existing population and net migration. Net migration, in turn, is affected by the future economic conditions in the area. People provide a market for goods and services as well as provide the labor which results in goods and services. All variables that combine to affect future population are subject to change; consequently, several different assumptions as to levels of population have been projected. Different assumptions about migration rates, fertility rates and other population determinants result in a variety of projections. The four population projections reviewed are as follows:

1. OBERS3/ E population projections provided a low estimate for the Republican Basin. That series of projections is from the Series E population estimates made by the Bureau of the Census.

2. The series used for the low was provided by the Bureau of Business Research, University of Nebraska at Lincoln (UNL).4/ This projection assumed an initial net outmigration of two percent, declining to 0.4 percent in the period 2015 to 2020.

3. The median UNL population projection was also provided by the Bureau of Business Research, UNL.4/ This projection assumed that Nebraska will have a zero net rate of migration (inmigrants will equal outmigrants).

3/ OBERS is an acronym that stands for the former Office of Business Economics (OBE, now called the Bureau of Economic Analysis), U.S. Department of Commerce and the former Economic Research Service (ERS, now called Economics, Statistics, and Cooperatives Service), U.S. Department of Agriculture.

4/ Nebraska Population Projections II, by Vickie Stepp and Duane Hackman, Bureau of Business Research, UNL, Lincoln, NE, Economic and Business Reports No. 14, July, 1976.

4. A fourth population projection was prepared by the Nebraska Natural Resources Commission (NRC).5/

The OBERS E projection provides the low bound of the four possibilities. The NRC projection is the only one showing an increase in population by 2020. UNL projections are between the OBERS E and NRC estimates. The UNL medium projection was selected for use in this study as being the most representative of what is foreseen to occur in the basin under future without accelerated resource development conditions (Table IV-4).

TABLE IV-4 POPULATION PROJECTIONS
Republican River Basin, Nebraska

Projection1/	1985	2000	2020
	(Number)		
OBERS E2/	55,714	50,756	47,448
UNL-Low2/	58,569	53,625	47,464
UNL-Medium2/	61,098	59,602	57,158
NRC	65,109	66,615	75,926

1/ See text for definition of acronyms and source.
2/ Data was adjusted to hydrologic boundaries.

Major Types of Economic Activity

Agriculture is the most important economic sector in the area. It follows that suppliers of inputs as well as purchasers of output for this sector are also a major source of economic activity even though they may not be located within the basin boundary. Agriculture will be described in more detail in a later section of this chapter.

The basin is void of large manufacturing plants. Industrial activity is quite limited as there currently are only six plants that have over 100 employees. Three of these firms are located in McCook, two in Superior and one in Holdrege. These plants produce a variety of items ranging from rubber hose, capacitors, medical supplies, aluminum products, portland cement, meat, and dairy products. There are several small manufacturing plants that produce items related to some facet of agriculture. Raw petroleum is pumped in a few locations of the basin.

5/ Republican River Basin Water Quality Management Plan, Nebraska Natural Resources Commission, May, 1976, p. 3-6.

Wholesale and retail trade is an important component of economic activity in the basin. The agricultural sector relies on the trade sector as a source for inputs needed in crop and livestock production. The trade sector also purchases some of the output from other sectors. Most of the products produced and marketed locally are purchased from the agricultural sector.

The service sector supports the basic industries of an area. This sector is important to the Republican Basin in terms of employment. Educational services, medical and health services, and personal services support most of these workers.

Employment

Employment is an important indicator of the presence or lack of economic activity in an area. One aim of this study is to provide long-run employment estimates for the basin considering alternative types and levels of resource developments. Census data regarding employment were obtained for a 12-county area known as the Water Resource Subarea (WRSA) 1025 in Nebraska and were expanded to the hydrologic area (Table IV-5). BEA data for the same counties were also expanded and are shown in Table IV-6.

The decrease in employment from 1950 to 1970 closely parallels population losses. Total employment declined 26 percent during these two decades. Agriculture and construction were the big casualties as employment declined over 50 percent in each of these categories. The declines in agricultural employment are somewhat typical of what has occurred throughout the Great Plains. Construction on several of the large reservoirs in the basin was underway in the late 1940's and early 1950's. This activity resulted in above normal construction employment.

Manufacturing and services were the major growth industries from 1950-1970 and continuing through 1974. The latter reflects the general tendency for more developed regions to become service oriented as personal income levels rise.

Employment data provides a useful picture of the numbers of people employed, what the structure of employment has been and how it had changed or is changing. However, this kind of information does not provide a complete picture of the economic and social well-being of all persons in the labor force. Some individuals in the labor force may be unemployed for a variety of reasons. However, unemployment above and beyond these special or specific cases generally results from existing business and economic conditions. Thus, data on employment and earnings can be misleading with respect to overall economic and social well-being if a large percentage of the labor force is unemployed or underemployed. Compared to State and national figures, the basin's economy was relatively free of unemployment all through the 1960's and early 1970's when

TABLE IV-5 EMPLOYMENT AND WORKERS
Republican River Basin, Nebraska

Item	1950	1960	1970	Change 50-60	Change 60-70	Distribution 1950	Distribution 1960	Distribution 1970
	(Number)			(Percent)				
Agriculture & Forestry	15,028	10,740	7,422	- 28.5	- 30.9	43.1	37.2	28.8
Mining	51	83	145	+ 62.8	+ 74.7	.2	.3	.6
Construction	3,818	1,725	1,605	- 54.8	- 7.0	10.9	6.0	6.2
Manufacturing	1,006	1,216	2,003	+ 20.9	+ 64.7	2.9	4.2	7.8
Machinery	(74)	(280)	(332)	+278.4	+ 19.4			
Food & Kindred	(464)	(528)	(578)	+ 13.8	+ 9.5			
Other Manufacturing	(468)	(408)	(1,093)	- 12.8	+167.9			
Trans., Comm. & Public Utilities	2,033	1,870	1,513	- 8.0	- 19.1	5.8	6.5	5.9
Wholesale & Retail Trade	5,708	5,548	5,456	- 2.8	- 1.7	16.4	19.2	21.2
Fin., Ins. & Real Estate	478	630	698	+ 31.8	+ 10.8	1.4	2.2	2.7
Services	4,869	5,313	5,835	+ 9.1	+ 9.8	13.9	18.4	22.6
Public Administration	1,044	1,408	1,092	+ 34.9	- 22.4	3.0	4.9	4.2
Other	856	351	N.A.	- 59.0	N.A.	2.4	1.1	N.A.
Total	34,891	28,884	25,769	- 17.2	- 10.8	100.0	100.0	100.0
Male	27,808	21,441	17,582	- 22.9	- 18.0	79.7	74.2	68.2
Female	7,083	7,443	8,187	+ 5.1	+ 10.0	20.3	25.8	31.8
Total Persons Who Worked in Prior Year		33,753	29,652	N.A.	- 12.2	N.A.	100.0	100.0
50-52 Weeks							65.0	63.6
40-49 Weeks							8.6	7.3
27-39 Weeks							8.2	9.7
14-26 Weeks							6.9	7.8
Less Than 14 Weeks							11.3	11.6
State of Nebraska	515,104	539,707	576,065	+ 4.8	+ 6.7	N.A.	N.A.	N.A.

Source: U.S. Census of Population Reports.

TABLE IV-6 EMPLOYMENT BY TYPE AND BROAD INDUSTRIAL SOURCES, FULL AND PART-TIME WAGE AND SALARY EMPLOYMENT PLUS NUMBER OF PROPRIETORS
Republican River Basin, Nebraska

	1970	1971	1972	1973	1974
Total Employment	29,973	30,528	30,896	31,882	32,840
Number of Proprietors	13,360	13,426	13,558	13,439	13,351
Farm	8,177	8,076	7,979	7,872	7,768
Nonfarm	5,183	5,350	5,579	5,567	5,583
Wage & Salary Employment	16,613	17,102	17,338	18,443	19,489
Farm	1,154	1,415	1,510	1,508	1,599
Nonfarm	15,459	15,687	15,828	16,935	17,890
Government	4,710	4,706	4,436	4,631	4,799
Federal	626	634	566	617	582
State and Local	4,084	4,072	3,870	4,014	4,217
Private Nonfarm	10,749	10,981	11,392	12,304	13,091
Manufacturing	812[d]	948[d]	1,130[d]	1,526[d]	1,755[d]
Mining	-[d]	8[d]	-[d]	20[d]	22[d]
Construction	578[d]	603[d]	527[d]	618	861
Trans., Comm. & Public Utilities	722[d]	755[d]	823[d]	891[d]	908[d]
Trade	4,930	5,050	4,754	5,009	5,150
Finance, Ins. & Real Estate	425[d]	419[d]	470[d]	540[d]	546[d]
Services	1,744	2,089	2,475	2,574	2,699
Other	7[d]	7[d]	10[d]	4[d]	4[d]

Source: Regional Economics Information System, Bureau of Economic Analysis
d Indicates the figure underestimates the actual value as a result of policies concerning the disclosure of confidential information.

unemployment rates ranged from 1.9 to 1.3 percent. However, about 10,000 persons migrated out of the basin between 1960 and 1970. Had these people remained, it is conceivable that many more would have been unemployed or underemployed.

High employment levels, however, do not insure that underemployment does not exist. An underemployed person is working, but at some job that provides less income than could be earned if his or her potential and skills were fully utilized. In other words, being employed does not mean that the individual is employed at a wage that is comparable to wages received by similar workers with similar characteristics in other areas of the national economy. These characteristics include both age, education and other selected attributes. They are compared with similar indicators for the nation as a whole. Severe underemployment occurs when the rate exceeds 20 percent.

In 1960, all counties in the basin had substantial (greater than 20 percent) underemployment among both the male and female labor force. Eleven counties had male underemployment over 30 percent, and two of these had underemployment over 40 percent. Fifteen counties had female underemployment greater than 40 percent and one county over 50 percent. Total underemployment in the basin for 1970 was about the same as in 1960. However, there were some large changes in some of the individual counties. Nine counties had less male underemployment in 1970, and seven had more underemployment. Female underemployment was less in three counties, the same in two counties and greater in 11 counties. Total labor economically underutilized in 1960 and the basin amounted to 13,034 man-years or 30.2 percent of the labor force. In 1970, economically underutilized labor was 13,029 man-years or 31.5 percent of the labor force.

Income

Personal income is one of the most comprehensive measures available for measuring the overall economic and business activity and general welfare in a regional economy. Personal income in this discussion is defined as total wages and salaries, other labor income, proprietor's income, property income, and transfer payments. It is measured prior to the deduction of income and other direct personal taxes but after deductions for Social Security contributions and government retirement programs.

Estimates of total personal income and per capita income for the Nebraska Republican River Basin are presented in Table IV-7 for selected years between 1959 and 1974. Total personal income in the area increased from an estimated $227.0 million in 1959 to $425.5 million in 1974. This represents an average annual growth rate of 5.8 percent per year. This rate of growth is slightly greater than for the State of Nebraska as a whole. Per capita estimates of personal income (total

TABLE IV-7 TOTAL PERSONAL AND PER CAPITA INCOME, 1959-1974 (1975 DOLLARS)
Republican River Basin, Nebraska

	1959[1/]	1970	1971	1972	1973	1974
Total Personal Income						
Basin[2/] ($1,000)	226,992	329,140	336,502	375,948	483,594	425,537
Nebraska ($1,000)	4,792,067	7,932,542	7,742,882	8,526,246	9,470,834	8,774,308
Basin as Percent of State	4.7	4.2	4.4	4.4	5.1	4.9
Per Capita Income						
Basin ($)	2,838	4,784	4,938	5,540	7,383	6,371
Nebraska ($)	2,945	5,331	5,134	5,582	6,180	5,688
U.S. ($)	4,187	5,326	5,420	5,700	5,979	5,823
Basin as Percent of State	96.4	89.8	96.2	99.2	119.5	112.0
Basin as Percent of U.S.	67.8	89.8	91.1	97.2	123.5	109.4

Source: Bureau of Economic Analysis, Regional Economics Information System and U.S. Census of Population.

1/ 1959 basin per capita personal income was derived by dividing 1959 personal income by 1960 population.

2/ Total personal income for the basin was approximated by expanding the 12-county WRSA 1025 personal income by the same ratio factor as used for employment.

personal income divided by total population) generally provide a more meaningful indication of the relative economic well-being of individuals than estimates of total income. These estimates indicate that real per capita incomes in the area, based on 1975 dollars, increased from $2,838 in 1959 to $6,371 in 1974. Over the period, per capita incomes in the basin began lower than the State or national average but ended higher than both.

Another measure of the relative economic well-being in a region is income distribution. Table IV-8 presents a percent income distribution of families for the Nebraska Republican River Basin, Nebraska and the U.S. for 1970. With regard to the percent distributions, there was not much difference between the three areas except that the basin had slightly larger percents of families at the lower levels and less at the higher levels of incomes. However, the basin's income distribution compared more favorably with the rural nonfarm and rural farm components of the U.S. total. These regions probably exhibit socioeconomic characteristics more like those of the basin.

Another useful measure of regional economic activity and growth is earnings by industrial sectors. Measured in constant dollars, earnings indicate the level and relative changes in the industrial structure of a region. Total earnings for the basin increased from $165.9 million in 1959 to $297.7 in 1974 (Table IV-9). Earnings were volatile during the last five years,and most of the variation was in the farm sector. The nonfarm sector of the economy has increased rather steadily since 1959 reaching a high of $156.4 million in 1974. The farm sector, on the other hand, reached a high of $201.7 million in 1973.

Cities, Towns and Transportation

McCook is the largest city in the basin. It is located in the south central portion of the basin and had a population of 8,285 in 1970. It is an important trade and service center for the basin and the surrounding area. Holdrege with 5,635 residents and Superior with a 1970 population of 2,779 are the next largest urban areas. The number of communities grouped by size category according to their 1970 population is as follows:

Size Category	Number of Communities	Total Population
2,500 or over	3	16,699
1,500 - 2,499	2	3,120
1,000 - 1,499	8	9,474
500 - 999	7	5,082
Less than 500	37	6,628

TABLE IV-8 INCOME DISTRIBUTION OF FAMILIES IN THE BASIN, NEBRASKA AND THE UNITED STATES, 1969
Republican River Basin, Nebraska

Family Yearly Income	Basin	Nebraska	United States			
			Total	Urban	Rural Nonfarm	Rural Farm
(Dollars)	(Percent)					
Less than 2,000	7.2	5.8	5.9	4.9	8.1	10.4
2,000 - 3,999	13.8	11.0	9.3	8.1	11.9	14.8
4,000 - 5,999	17.3	13.4	10.8	9.8	13.0	15.3
6,000 - 7,999	17.3	15.3	12.8	12.1	15.1	14.3
8,000 - 9,999	14.9	15.2	13.9	13.6	14.9	12.6
10,000 - 14,999	19.2	24.4	26.6	28.0	23.8	19.2
15,000 - 24,999	7.7	11.7	16.0	18.0	10.7	9.9
25,000 and Over	2.6	3.2	4.6	5.3	2.6	3.3
	(Dollars)					
Average Income	8,452	9,792	10,999	11,674	9,251	8,795
Median Income	7,331	8,564	9,590	10,196	8,248	7,296

Source: U.S. Bureau of Census, 1970 Census of Population.

TABLE IV-9 ESTIMATED EARNINGS BY BROAD INDUSTRY SECTORS
Republican River Basin, Nebraska

Item	1959	1970	1971	1972	1973	1974
	(Thousands of Dollars)					
Total Earnings	165,907	211,130	223,919	255,706	352,896	297,749
Farm Earnings	63,887	74,966	90,322	116,437	201,714	141,336
Total Nonfarm Earnings	102,020	136,164	133,597	139,269	151,182	156,413
Government Earnings	20,783	32,431	32,310	32,689	35,430	34,171
Federal	7,881	8,724	9,101	9,047	9,671	8,844
State & Local	12,902	23,707	23,209	23,642	25,759	25,327
Private Nonfarm Earnings	81,237	103,733	101,287	106,580	115,752	122,242
Manufacturing	4,639	9,246	10,608	11,912	14,293	16,153
Mining	1,767	847	971	1,091	1,309	1,479
Contract Construction	4,665	8,021	8,043	8,797	9,743	12,022
Trans., Comm. & Public Utilities	14,374	11,869	9,677 1/	10,848 1/	11,937 1/	11,732 1/
Wholesale & Ret. Trade	35,931	41,868	42,504	42,104	44,218	46,410
Fin., Ins. & Real Estate	3,077	5,935	5,967 1/	6,582 1/	6,778 1/	6,276 1/
Services	13,970	21,565	18,490	19,602	20,701	20,516
Other	2,814	4,381	5,027	5,644	6,773	7,654

Source: Regional Economics Information System, Bureau of Economic Analysis. BEA data converted to 1975 dollars using personal consumption expenditures price deflators.
1/ Estimated by ESCS.

McCook has the only airport in the basin that provides regularly scheduled commercial flights. U.S. Highways 6, 34 and 136 span the basin from east to west, and U.S. Highways 83, 183, 281, and 283 cut across the basin from north to south. Several State highways are also available for transportation of people, freight and other products. Both passenger and freight trains service the basin.

Export Base

Export industries are those industries which produce more goods and services than are needed in the local economy. This export position causes income to flow into the regional economy, and it is this income which supports other local economic activity. By causing income to flow into the region, the export industries serve as the base of the regional economy and are, thus, referred to as "basic" industries. The remaining industries (non-export) are referred to as "nonbasic" or service industries. They are sometimes called service industries because demand for their output is derived from the demand for output of basic industries.

Location quotients are used to differentiate between basic and nonbasic industries. The local quotient is a computation which can be used to compare the percentage share of a particular activity within a region to the percentage share of the same activity for some large aggregate such as the nation. Percentage shares will be compared for broad industry subsectors of the basin economy. The comparison will identify the economic activities in which the region has tended to specialize and which make up the basic or export industries. Those regional activities whose location quotients are greater than 1.0 are considered basic industries, and those with a location quotient less than 1.0 are considered "nonbasic" industries. Activities with location quotients of 1.0 are considered neutral in export-base theory - neither bringing income into the region nor draining it out.

Agriculture is firmly established in the export-base of the basin's economy (Table IV-10). The location quotient has been well above unity throughout the 1950-1974 period. In fact, the location quotient has shown an upward trend since 1950 reflecting a continued dependence on the basin's economy on agricultural activities. Wholesale and retail trade and State and local government historically have had location quotients greater than one. By 1974, these sectors had become less important in the basin's economy relative to their economic importance at the national level. Estimated export earnings were computed for each of the export industries and are presented in Table IV-11.

TABLE IV-10 LOCATION QUOTIENTS FOR EARNINGS
Republican River Basin, Nebraska

Sector	1950	1959	1965	1967	1970	1972	1974
Farm Earnings	6.24	9.00	10.84	11.72	11.62	13.76	12.95
Total Nonfarm Earnings	.50	.63	.58	.61	.65	.56	.54
Government Earnings	.86	.95	.88	.88	.93	.71	.66
Federal	.59	.75	.73	.66	.63	.51	.27
State & Local	1.14	1.13	.99	1.05	1.15	.85	.77
Private Nonfarm Earnings	.45	.57	.53	.56	.58	.52	.52
Manufacturing	.04	.07	.07	.09	.12	.17	.20
Mining	.10	.76	.62	.57	.40	.44	.46
Contract Construction	.85	.44	.46	.51	.59	.54	.65
Trans., Comm. & Public Utilities	.56	1.06	.77	.70	.76	.58	.55
Wholesale & Ret. Trade	.81	1.15	1.06	1.14	1.14	1.00	.95
Fin., Ins. & Real Estate	.24	.37	.49	.49	.53	.47	.41
Services	.53	.65	.65	.72	.67	.50	.45

Source: Bureau of Economic Analysis data.

Table IV-11 ESTIMATED EARNINGS DUE TO EXPORT ACTIVITIES
Republican River Basin, Nebraska

Industry	1959	1970	1974
	(Thousands)		
Farm	56,789	68,511	130,425
State & Local Gov't	1,489	3,091	1/
Wholesale-Retail	4,685	5,141	1/
Other	2,269	3,746	6,737
Total Export Earnings	65,226	80,489	137,162
Total Earnings	165,907	211,130	297,749
	(Percent)		
Export's Share of Total Earnings	39.3	38.1	46.1

Source: Economics, Statistics, and Cooperatives Service, Lincoln, Nebraska, 1975 dollars.
1/ No net exports.

Agriculture

Agriculture is the most important sector of the Republican basin economy. Although the number of farms and farm operators is declining, agriculture is expanding as an industry. It is growing in terms of value of production as well as product diversification. This inverse relationship between fewer producers and greater output is largely due to an increase in farm efficiency through judicious use of conservation programs, resource developments, improved technology, feed additives, fertilizers, insecticides, and larger farm machinery. Further efficiencies can be expected in the future.

As the population of the nation increases, larger quantities of agricultural products will be required to meet the domestic demand as well as fulfilling net exports to foreign countries. The Republican River Basin will provide a share of these agricultural products. When per capita incomes rise, consumers tend to increase expenditures for some food items, especially beef. Beef production is the most important source of farm income from livestock to the basin. The number

of fed cattle has increased as production of feed crops expanded. The major crops - wheat, corn for grain and silage, grain sorghum, small grains, hay and pasture, soybeans, sugar beets, and dry beans also produce important amounts of farm income.

Farm Numbers and Sizes

Between 1954 and 1974, the number of farms in the basin decreased from 8,889 to 5,951 (Table IV-12), a trend that is consistent with comparable observations at State and national levels. Consequently, as farm numbers decline, the average size increased. During the decade prior to 1974, the average size in the basin increased from 603 acres to 854 acres, an increase of 42 percent.

Further insight of the effects from increasing farm size can be enhanced by noting changes in the distribution of farms between size categories (Table IV-13). Significant increases are shown for the very small and very large farms. The former is a result of nonfarm residents who wish to live in a rural setting, while the latter is the direct result of fewer but larger farms. When the size categories for the basin are compared with similar data for the entire State, it should be noted that farms tend to be larger in the basin. Incidentally, it is noted that in 1974, about 89 percent of the farms were considered family farms. Partnerships accounted for nine percent and corporations two percent.

The reduction in farm numbers is prime evidence that the rural-farm population is also declining. Increasing capital requirements are one of the major reasons why people leave the farm. The cost of acquiring land and improvements as well as the cost of machinery to operate the land continues to rise (Table IV-14). Land value per farm increased from $182.0 thousand to $260.6 thousand, increasing about 43 percent during the period 1969 to 1974. The average investment per farm in machinery and equipment increased 55 percent during the same period, increasing from $25.9 thousand to about $40.0 thousand.

TABLE IV-12 HISTORICAL RECORD OF FARM NUMBERS AND AVERAGE FARM SIZE
Republican River Basin, Nebraska

	1954	1959		1964		1969		1974	
	Number	Number	% Change	Number	% Change	Number	% Change	Number	% Change
Farms									
Basin	8,889	7,963	-10.4	6,980	-12.3	6,376	- 8.7	5,951	- 6.7
Nebraska	100,846	90,475	-10.3	80,163	-11.4	72,257	- 9.9	68,973	- 4.5
United States	4,782,000	3,711,000	-22.4	3,158,000	-14.9	2,730,000	-13.5	2,450,000	-
Average Farm Size	— (Acres) —			(Acres)		(Acres)		(Acres)	
Basin	603	631	4.6	693	9.8	723	4.3	854	18.1
Nebraska	471	528	12.1	596	12.9	634	6.4	672	6.0

Source: U.S. Census of Agriculture.

TABLE IV-13 DISTRIBUTION OF FARMS BY SIZE
Republican River Basin, Nebraska

Size Category (Acres)	Basin 1959	Basin 1964	Basin 1969	Basin 1974	Nebraska 1974
	(Percent)				
Less than 10	2.3	2.1	5.2	4.6	5.0
10 - 49	3.4	3.8	2.7	2.8	5.0
50 - 99	2.5	2.5	2.4	3.4	6.3
100 - 179	7.7	7.0	7.4	7.8	14.0
180 - 259	6.1	4.7	4.6	4.9	10.3
260 - 499	29.2	25.2	21.6	19.1	26.8
500 - 999	31.0	31.4	28.9	27.8	18.6
1,000 - 1,999	14.1	17.9	20.6	20.7	8.5
2,000 and Over	3.6	5.6	6.7	8.9	5.5

Source: U.S. Census of Agriculture.

TABLE IV-14 VALUE OF LAND AND BUILDINGS; MACHINERY AND EQUIPMENT
Republican River Basin, Nebraska

Item	Basin	State of Nebraska
	(Dollars)	
Value of:		
Land & Buildings Per Farm		
1969	182,028	185,462
1974	260,551	220,382
Machinery & Equipment Per Farm		
1969	25,877	25,017
1974	39,997	35,573

Source: U.S. Census of Agriculture.
Note: 1975 Dollars.

Value of Sales

Crop and livestock production are both important contributors to the sale of agricultural output from the basin. Sales increased about 243 percent from 150.3 million to 365.5 million dollars between 1954 and 1974 (Table IV-15). Livestock sales accounted for an increasing

TABLE IV-15 VALUE OF AGRICULTURAL SALES
Republican River Basin, Nebraska

Year	All Farm Products Sold			
	Thousand (Dollars)	Share of State (Percent)	Sold As: Livestock (Percent)	Crops (Percent)
1954	150,228	9.0	47.3	52.7
1959	197,732	8.5	53.3	46.7
1964	216,403	8.3	62.0	38.0
1969	289,460	7.7	63.8	36.2
1974	365,514	10.2	39.5	60.5

Source: U.S. Census of Agriculture reports.
Note: 1975 Dollars.

share of all sales up through 1969. By 1974, a complete reversal occurred due to record production and high prices for crops. The basin produced about 10 percent of the total value of State agricultural output in 1974. This is somewhat higher than the 7.7 percent of sales in 1969.

Major Crop Enterprises

Wheat, corn, grain sorghum, and hay are the major crops grown in the basin. They, along with range, are important in terms of acres and production. Historical acreages of harvested crops grown under nonirrigated as well as irrigated conditions are shown in Table IV-16. Noticeable trends have occurred for several crops, especially the downward trend for nonirrigated corn and sharp upward turn for irrigated corn. Grain sorghum acreage and production increased rapidly during the droughts of the 1950's and 1960's. Government programs have had an

Wheat is the Major Crop Grown on Nonirrigated Land

effect on crop acreages. Wheat is a good example where the acreage was somewhat stable during the 1950's, 1960's and early 1970's, then increased substantially in 1973 and again in 1974.

Corn is the Major Crop Irrigated in the Basin

TABLE IV-16 HARVESTED CROPS
Republican River Basin, Nebraska

Crop		1949	1954	1959	1964	1969	1970	1971	1972	1973	1974	1975
		(Acres)										
Wheat	NI	884,161	647,750	685,750	627,628	653,790	636,382	646,556	689,560	762,750	792,555	780,510
	Irr	2,280	823	2,371	2,845	1,636	1,419	1,888	1,980	1,522	7,553	14,304
Rye	NI	10,175	12,605	30,149	34,806	29,747	47,567	11,370	10,422	9,595	7,326	7,326
Corn for Grain	NI	704,812	683,100	498,049	142,756	76,081	105,006	117,216	112,221	131,091	105,339	88,911
	Irr	17,242	14,223	64,879	97,124	249,901	276,398	331,828	341,333	387,270	442,375	469,728
Silage	NI	-	83,111	57,736	51,521	33,289	27,062	24,153	22,755	28,971	29,415	22,200
	Irr	767	1,518	6,167	12,371	12,784	23,304	27,683	29,584	27,448	31,186	32,040
Grain Sorghum	NI	45,189	193,805	288,868	387,518	243,724	277,167	323,942	254,634	332,001	285,492	247,197
	Irr	326	908	2,765	12,731	16,981	13,724	16,404	11,641	15,166	15,486	19,224
Oats	NI	48,420	24,730	7,444	14,644	23,649	32,006	19,811	9,131	8,564	10,215	8,874
	Irr	999	777	466	364	1,881	1,277	730	N.A.	N.A.	N.A.	N.A.
Barley	NI	21,232	22,273	63,613	14,934	4,065	2,301	2,992	1,939	1,754	1,341	1,858
Hay	NI	195,624	324,316	198,185	223,678	160,507	196,833	196,248	175,848	193,800	157,352	179,112
	Irr	5,276	15,768	15,740	20,686	45,363	40,817	38,318	41,531	43,770	45,915	49,125
Soybeans	NI	108	178	71	262	4,315	2,520	462	700	3,200	1,120	1,400
	Irr	-	67	-	322	-	1,754	102	292	2,193	731	1,754
Sugar Beets	Irr	211	331	404	1,134	11,404	9,080	8,140	7,340	7,187	6,033	9,928
Dry Beans	Irr	40	111	1	20	2,280	4,650	5,040	5,900	7,000	7,395	8,084
Total	NI	1,909,721	1,919,868	1,829,585	1,497,747	1,229,167	1,326,844	1,342,750	1,277,210	1,471,746	1,390,155	1,337,388
	Irr	27,141	34,526	92,793	147,597	342,230	372,423	430,133	439,601	491,556	556.674	604,187

Source: U.S. Census of Agriculture for 1949 through 1969. Statistical Reporting Service for the remaining years.

Harvested cropland that received supplemental irrigation water increased more than twentyfold between 1949 and 1975. Most of this new irrigation occurred on land that had been cropped previously. There also has been some conversion from rangeland to irrigated cropland. Total land in crop production was higher at the beginning and end of the 1949-1975 period, but lower during the middle years. The upward trend in later years was an important factor in rising production levels.

Crop production for selected years is shown in Table IV-17. For several crops, much of the growth in production can be explained by the rapid expansion in irrigation and improved irrigation technology. Data shown in the last column are referred to as the base. These production levels reflect conditions for an average of a three-year period, 1973 through 1975. Acres of crops for the same period along with production and value of production are shown in Table IV-18.

Major Livestock Enterprises

The livestock industry is an important element of the basin economy. Composition of this industry changed considerably between 1949 and 1975.

Cattle Ranching is Important to the Basin Economy

Changes in locational advantages of markets and in demand patterns tend to alter the relative importance of various types of livestock. Beef cattle, hog and sheep numbers have increased. Meanwhile, dairy cattle

TABLE IV-17 HISTORICAL CROP PRODUCTION
Republican River Basin, Nebraska

Crop	Unit	1949	1954	1959	1964	1969	Base[1]
		(Thousands)					
Wheat	Bu.	10,258.9	12,616.6	15,649.6	12,922.0	23,438.7	27,758.9
Rye	Bu.	74.1	120.5	411.6	532.1	610.4	173.0
Oats	Bu.	1,038.2	539.9	132.0	462.3	1,069.0	374.3
Barley	Bu.	278.6	308.6	1,455.2	286.8	147.2	55.1
Corn for Grain	Bu.	15,666.5	11,179.2	17,089.4	12,054.1	32,279.6	51,517.1
Silage	Tons	-	207.5	241.2	423.4	509.6	696.1
Grain Sorghum	Bu.	867.4	3,905.1	7,891.9	12,272.0	14.123.8	12,773.0
Soybeans	Bu.	1.8	3.4	1.0	9.0	114.8	95.1
All Hay	Tons	269.6	428.5	324.6	420.7	617.1	573.4
Sugar Beets	Tons	3.0	4.6	8.2	19.6	154.2	131.9
Irish Potatoes	Cwt.	14.9	6.1	6.0	59.2	23.4	3.9
Dry Beans	Cwt.	0.1	1.2	0.0	0.1	47.0	121.4

Source: U.S. Census of Agriculture for 1949, 1954, 1959 and 1964. Statistical Reporting Service for 1969 and base.
1/ Base is average of 1973-1975.

TABLE IV-18 ACRES, PRODUCTION AND VALUE OF PRODUCTION FOR BASE PERIOD
Republican River Basin, Nebraska

Crop	Production Unit	Acres	Production	Dollars 1/
		(Thousands)		
Cropland		3,060.1		295,383.1
Nonirrigated		2,482.0		153,584.0
Wheat	Bu.	778.9	27,417.5	90,751.9
Rye	Bu.	8.1	173.0	356.3
Silage	Tons	26.9	209.5	2,771.8
Corn for Grain	Bu.	108.4	4,565.3	11,230.7
Grain Sorghum	Bu.	288.2	11,644.5	25,967.3
Oats	Bu.	9.2	374.3	531.4
Barley	Bu.	1.7	55.1	113.0
Alfalfa Hay	Tons	77.4	185.8	7,804.8
Other Hay	Tons	99.3	188.7	7,737.5
Soybeans	Bu.	1.9	46.0	231.6
Fallow		717.7	-	-
Cropland Pasture	AUM	169.1	507.3	6,087.7
Idle		195.2	-	-
Irrigated		578.1		141,799.1
Wheat	Bu.	7.8	341.4	1,130.1
Corn for Grain	Bu.	433.1	46,951.8	115,501.5
Grain Sorghum	Bu.	16.6	1,128.5	2,516.6
Silage	Tons	30.2	486.6	6,438.0
Alfalfa Hay	Tons	46.3	198.9	8,355.5
Soybeans	Bu.	1.6	49.1	247.7
Sugar Beets	Tons	7.7	131.9	4,589.7
Dry Beans	Cwt.	7.5	121.4	2,134.5
Cropland Pasture	AUM	6.2	73.8	885.5
Idle		21.1	-	-
Pasture	AUM	33.0	225.7	2,708.9
Irrigated	AUM	16.8	201.4	2,416.9
Nonirrigated	AUM	16.2	24.3	292.0
Range	AUM	2,789.0	1,032.0	12,383.4
Forest	AUM	40.0	11.8	142.0
Grazed	AUM	32.0	11.8	142.0
Not Grazed		8.0		
Other Ag. Land		97.8		
Total		6,019.9		310,617.4

1/ Value is based upon Nebraska prices in Agricultural Price Standards, Water Resources Council, October 1976.

and chicken numbers declined (Table IV-19). Cattle feedlot capacity has increased in recent years because of the expansion in feed grain and silage production. Also, a good supply of feeder cattle is produced in the basin and surrounding areas.

OBERS Projections

The Water Resources Council, U.S. Department of Commerce and U.S. Department of Agriculture have prepared several estimates of future economic activity for the nation, States and smaller areas. These estimates are commonly referred to as OBERS baseline projections. OBERS projections at the national level are projections of future demands for the various agricultural commodities. These projections consider future changes in income, per capita consumption rates, relative prices of products, population, and export-import relationships.

The OBERS projections were designed for at least three major uses:6/

1. For the assessment of future demands for water and related land resources;

2. As indicators of potential economic problems in an area; and

3. As a benchmark framework for evaluation purposes.

The first step in developing the specific crop and livestock projections was to project national demands. These projections were made by ESCS in Washington, D.C. By assuming different characteristics for some of the demand variables, different series of national demands can be projected. This study uses three such series of national demand projections - OBERS E, OBERS E' and OBERS E' with high exports. Series E' and E' high exports projections were made for agriculture only.

Table 20 depicts the current net exports (imports) of the various commodities as used in the three series as well as projections for years 1985 and 2000. Note that a negative (-) number means net imports. For example, under Series E, the U.S. is expected to have net imports of 2,163 million pounds of beef and veal by 1985 compared to an average of 1,753 million pounds over the period 1972-1974.

Disaggregation of OBERS Projections

Once the national projections were made, they were disaggregated to the various States and then further reduced to the study area.

6/ Ibid, p. 7.

TABLE IV-19 LIVESTOCK NUMBERS
Republican River Basin, Nebraska

Type of Livestock	1949	1954	1959	1964	1969	Base[1/]
	(Number)					
Cattle	320,381	421,046	411,461	514,178	560,261	667,576
Cows & Heifers That Have Calved	148,000	199,343	178,805	218,724	230,740	277,587
Milk Cows	38,879	34,042	23,462	15,874	8,311	7,466
Hogs	138,505	126,513	170,273	166,081	200,983	227,037
Sheep	7,482	22,381	28,878	36,145	34,535	24,347
Chickens	876,234	836,567	649,221	335,937	127,597	139,721
Horses & Ponies	N.A.	9,882	6,638	N.A.	5,502	3,525[2/]

Source: U.S. Agricultural Census, 1949-1969; Nebraska Agricultural Statistics, 1973-1975 base.

1/ Average of 1973-1975.

2/ Agricultural Census, 1974.

TABLE IV-20 NET EXPORTS OF AGRICULTURAL COMMODITIES, OBERS E, OBERS E' AND OBERS E' HIGH EXPORTS
United States

Commodity	Unit	Exports- 3-Year Average	E 1985	E 2000	E' 1985	E' 2000	E' High Export 1985	E' High Export 2000
			(Millions)					
Corn	Bu.	1,368 1/	1,188	1,275	989	2,069	1,889	3,298
Sorghum	Bu.	190 2/	202.4	217.3	160	380	270	450
Wheat	Bu.	1,136 1/	784.7	814	774	919	1,179	1,479
Rye	Bu.		7.4	7.7	7.4	7.7	7.4	7.7
Barley	Bu.	68 2/	93	96.4	20	35	25	40
Oats	Bu.	35 2/	4.7	4	10	21	19	29
Soybeans	Bu.	505 1/	598.5	684	950	1,475	1,125	1,700
Cotton	Bales	4.5 1/	3.5	3.5	4.1	4.2	4.2	4.6
Beef & Veal	Lbs.	-1,753 3/	-2,163	-2,909	-2,169	-2,924	-1,190	-1,760
Milk	Lbs.		- 500	- 500	- 680	-1,040	- 680	-1,040
Pork	Lbs.	- 269 3/	- 275	- 325	- 307	- 351	- 307	- 351
Lamb & Mutton	Lbs.	- 69 3/	- 184	- 203	- 230	- 274	- 230	- 274
Turkey	Lbs.		35	35	70	80	70	80
Broilers	Lbs.		133	90	235	253	235	253
Eggs	Doz.		44	50	44	50	44	50

1/ Based on an average of 73-74, 74-75, and 75-76 marketing years which vary for the commodities as to dates. From Agricultural Outlook, ESCS, USDA, March 1977.

2/ Average of 1971, 1972, and 1973. From Agricultural Statistics, USDA, 1975.

3/ A negative means net import. The figures in the 3-year column for livestock are based on 1972 through 1974 net export average from Agricultural Statistics, USDA, 1975.

Projected Crop Production

The three levels of projected needs for crop production in the basin are shown in Table IV-21. There is no difference between E' and E' high export projections for some crops, e.g., sugar beets. The latter happens because the export assumptions were not changed between the two series for that particular crop.

Wheat requirements are projected to be about 10 percent higher than current by year 2000 in Series E to over 68 percent higher than current by year 2000 in Series E' high export. Corn requirements for year 2000 are 39 percent higher under Series E and almost 205 percent higher with the Series E' high export assumptions. A large part of the increased corn production in the area is due to the rapid expansion of irrigation which, in turn, affects the basin's share of State production. Grain sorghum is another crop for which projected requirements represent substantial increases over the current situation. Some crops such as barley and oats show reduced requirements by year 2000 compared to the base for all three projection levels.

Projected Livestock Production

Livestock and livestock product projections are shown in Table IV-22. Only the beef and veal projections are different between Series E' and E' high export since that is the only livestock category whose import-export assumptions were changed. Imports of beef and veal were reduced for the E' high export model.

Generally, Series E' high export projections show the highest need for most of the area's agricultural commodities while E projections are lowest. There are exceptions, however, such as lamb and mutton. The latter can be explained by examining the import-export and per capita consumption figures for lamb and mutton.

Forestry Resources

The basin has the capacity to sustain a harvest of about 16,000,000 board feet per year if 40,000 acres were placed under management. This level of production could not be achieved within the near future and, in fact, may never occur. On average sites (100 ft. 3/ac./yr.), the internal rate of return to a landowner planting genetically improved cottonwood is around five percent. On good sites (200 ft. 3/ac./yr.), the internal rate of return is eight percent. If the forestland is good enough to clear and grow crops on, the economic returns from cropping will be greater than for timber management. If the soil isn't good enough to grow crops, the forestry returns will probably not induce landowners to intensively manage their forestland for timber production.

TABLE IV-21 OBERS SERIES E, E' AND E' WITH HIGH EXPORT PROJECTIONS OF CROP PRODUCTION
Republican River Basin, Nebraska

Crop	Unit	Base 1/	E			E'			E' High Export		
			1985	2000	2020	1985	2000	2020	1985	2000	2020
			(Thousands)								
Wheat	Bu.	27,758.9	25,853.8	30,612.5	36,098.8	29,752.5	36,749.8	45,674.6	34,231.7	47,129.0	58,573.1
Rye	Bu.	173.0	331.9	295.7	255.3	446.0	496.2	542.9	448.9	499.4	546.4
Corn for Grain	Bu.	51,517.1	58,250.8	71,730.3	84,286.1	62,708.7	89,338.2	104,521.9	65,901.8	105,454.8	123,377.7
Silage	Tons	697.1	632.3	656.5	661.4	684.9	753.0	811.2	696.6	766.7	826.0
Grain Sorghum	Bu.	12,733.0	20,474.4	23,355.6	26,056.2	20,110.8	26,917.6	30,184.5	20,442.6	29,945.9	33,580.3
Oats	Bu.	374.3	251.3	138.4	65.0	277.2	191.1	113.0	284.0	195.4	115.5
Barley	Bu.	55.1	33.6	6.6	1.0	36.9	7.9	1.3	75.5	16.1	2.7
All Hay	Tons	573.4	606.4	698.8	770.9	663.8	810.4	938.8	614.5	843.2	976.8
Soybeans	Bu.	95.1	87.4	110.0	133.4	119.0	181.2	205.8	132.8	209.9	238.5
Sugar Beets	Tons	131.9	101.1	106.7	111.1	139.3	148.3	157.7	139.3	148.3	157.7
Dry Beans	Cwt.	121.4	105.6	119.0	127.6	98.0	100.7	109.5	98.0	100.7	109.5

Source: Disaggregated from various OBERS projections reports.
1/ Represents average of 1973 through 1975.

TABLE IV-22 CURRENT PRODUCTION AND OBERS SERIES E, E' AND E' WITH HIGH EXPORT PROJECTIONS OF LIVESTOCK PRODUCTS
Republican River Basin, Nebraska

Product	Unit	Base	Series E			Series E'			Series E'-High Export		
			1985	2000	2020	1985	2000	2020	1985	2000	2020
		(Thousands)									
Beef & Veal	Lb.	261,380	334,578	397,107	469,762	336,768	426,887	501,048	347,881	440,974	517,583
Pork	Lb.	78,362	118,975	147,898	179,340	113,450	148,299	184,804	113,450	148,299	184,804
Lamb & Mutton	Lb.	1,134	1,742	1,540	1,303	647	540	579	647	540	579
Milk	Lb.	69,700	56,560	45,329	34,342	61,852	46,134	36,414	61,852	46,134	36,414
Chickens	Lb.	330	281	116	42	309	128	46	309	128	46
Eggs	Doz.	2,667	2,206	1,119	586	1,955	1,126	585	1,955	1,126	585

Source: Disaggregated from various OBERS projections reports.

An increase in stumpage price could change the profitability of intensive forest management. This is unlikely to occur due to the linear distribution of the resource which causes higher transportation costs than a similar acreage in a block pattern.

The Nebraska State Forester estimated that there were 56,000 acres of forested land in the basin in 1955. By 1969, this had decreased to approximately 47,100 acres. Recent estimates indicate there were only about 40,000 acres remaining in 1977. The economics of the situation helps explain the decrease in forestland acreage. Changes in fossil fuel availability and cost could affect agricultural practices. Some people believe the demand for wood may outstrip supply, and prices may increase significantly resulting in more land placed in timber production.

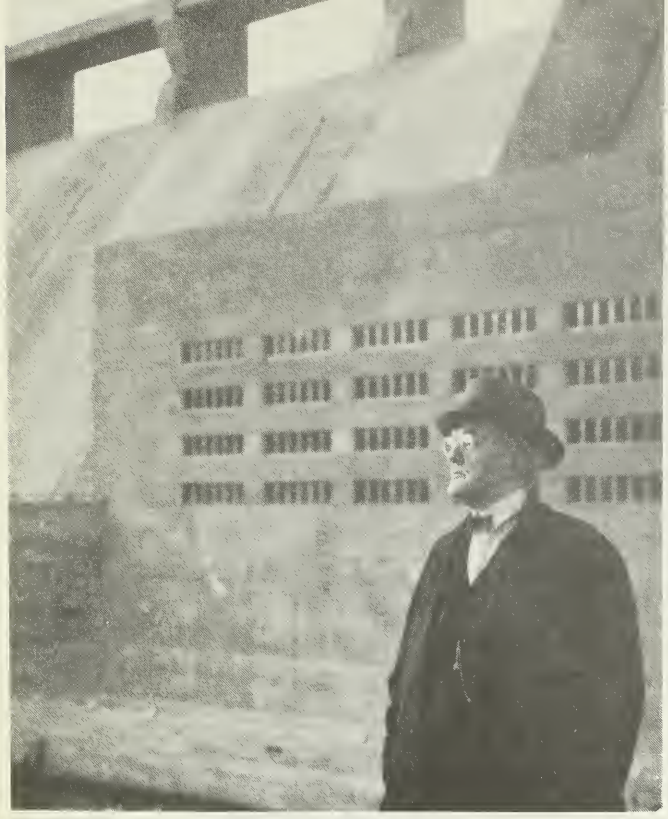
Economic Value of Forest Resource

In 1969, the total volume of cottonwood, hackberry and ash sawtimber in Nuckolls, Webster, Franklin, Harlan, Furnas, and Red Willow Counties was 58 million board feet (int. ¼"). At a stumpage value of $10 per thousand board feet, this is a total standing timber value of $580,000. The harvesting of and production of lumber from these stands could generate significant employment if markets for forest products were available.

Recreation Resources

The varied topography of the basin provides many scenic vistas. The basin traveler will find high plains and sandhills in the west, steep canyons in the central and rolling hills in the east. A variety of recreational opportunities can be found throughout the basin (Plate 4). However, the majority of public recreation facilities are water-oriented. The surface waters in the basin provide many recreational opportunities including fishing, boating, waterskiing, canoeing, hunting, and swimming. Associated activities such as picnicking and camping are very popular on the five large reservoirs in the basin.

A recreation inventory of areas and facilities was compiled in the Nebraska State Comprehensive Outdoor Recreation Plan (SCORP) in 1973 and is tabulated for the basin in Table IV-23. Sites inventoried included those administered by Federal, State and municipal governments. Listed in Table IV-24 are the private recreation resources as compiled in the National Association of Conservation Districts' "Private Sector Recreation Inventory", 1974. Outdoor recreation resources provided by municipalities are shown in Table IV-25.



GEORGE NORRIS
Nebraska's famed Senator 1913-1943
Father of TVA, REA, Irrigation Structures
and Nebraska's Unicameral Legislature.

GEORGE NORRIS HOME in McCook

Willa Cather, Nebraska's Pulitzer Prize-Winning
novelist called Red Cloud her home.

Headquarters of Willa Cather
Memorial-Nebr. Historical Soc.

Pavelka Farm Home "My Antonia"

Photo Credits: Nebraska
State Historical Society

RECREATIONAL, HISTORICAL, AND CULTURAL FEATURES MAP

REPUBLICAN RIVER BASIN

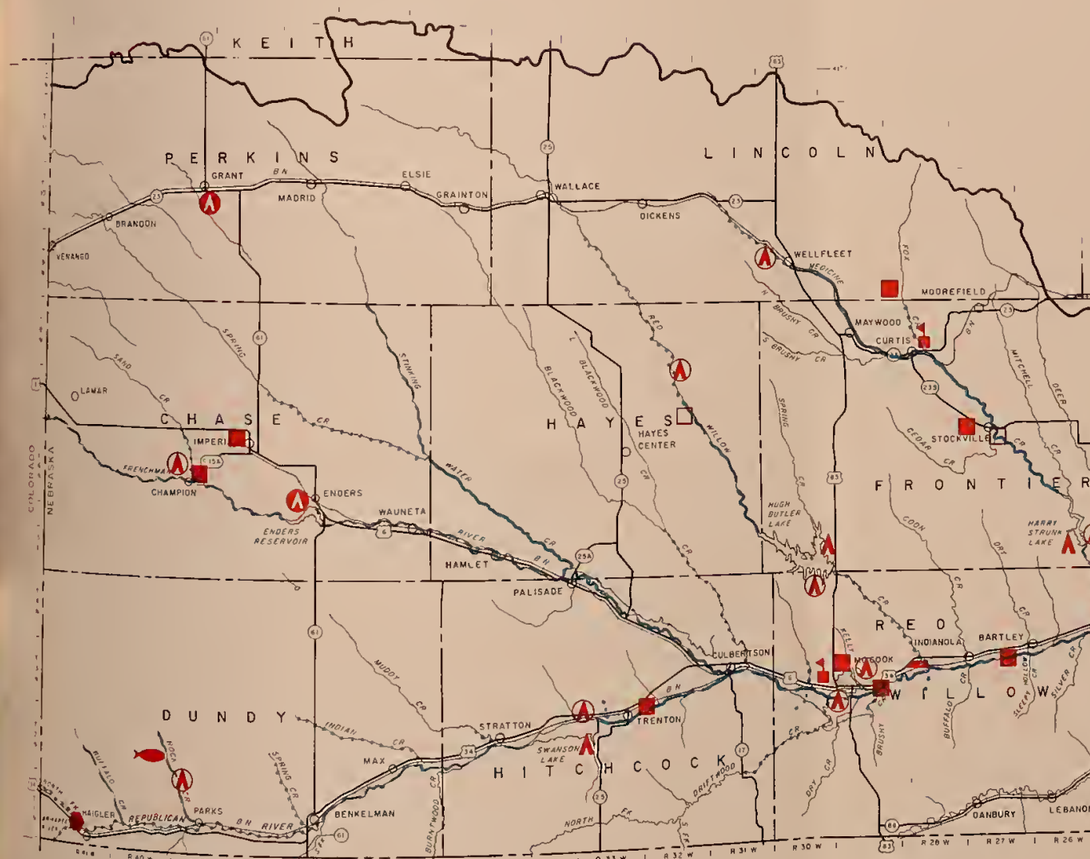
NEBRASKA

LEGEND

SERVICE
FULL - BASIC

- HIGHWAY REST AREA
- HISTORICAL PARK, MEMORIAL OR POINT OF INTEREST
- PUBLIC CAMPING, RECREATION OR SPECIAL USE AREA
- COMMERICIAL CAMPING OR RECREATION AREA
- FISH HATCHERY
- COLLEGE
- STATE WAYSIDE AREA

MILES	RANKING	STREAMS FOR SPORT FISHERY VALUE
275	I	STREAMS WITH SUBSTANTIAL FLOWS AND STATEWIDE SIGNIFICANCE AND IMPORTANCE AS A FISHERY
74	II	STREAMS WITH GOOD FLOWS AND LOCAL SIGNIFICANCE AND IMPORTANCE AS A FISHERY. DOES NOT HAVE COMPARABLE FLOWS OF A CLASS I NOR IS THE FISH POPULATION AS LARGE.
198	III	STREAM IS OF LOCAL SIGNIFICANCE FLOWS ARE SMALL BUT IMPORTANT TO HIGHER CLASS STREAMS FISH USUALLY CONSIST OF CARP, BULLHEADS, AND MINNOWS
446	IV	MINNOW FISHERY. THESE STREAMS MAY DRY UP DURING PERIODS OF DRY WEATHER FISHERY IS IMPORTANT AS A FOOD SOURCE FOR DOWNSTREAM FISHERIES.
993		TOTAL STREAM MILES OF FISHERY VALUE



SCALE 1/800,000
0 5 10 15 20 25 30 MILES
0 5 10 15 20 25 30 35 40 45 KILOMETERS

SOURCE
SCS STAFF, E.R. 76-1181REV 7-781, NEBRASKA GAME AND PARKS COMMISSION, AND INFORMATION FROM FIELD TECHNICIANS
TRANSVERSE MERCATOR PROJECTION

PLATE 4
9-19-78
5,5-37,000

TABLE IV-23 STATE AND FEDERAL RECREATION FACILITIES
Republican River Basin, Nebraska

County	Recreation Area	Type 1/	Acres				Picnicking			Camping			Boat Ramps	Beaches		Activities 2/												
			Total	Land	Water	Marsh	Acres	Sites	Tables	Acres	Sites	Units		Sites	Acres	Swimming	W. Skiing	Fishing (WW)	Fishing (CW)	Picnicking	Boating (P)	Boating (NP)	Hunting (BG)	Hunting (SG)	Hunting (WF)	Tent	Trailer	Hiking
State Areas																												
Frontier	Medicine Cr.	SUA,SRA	8,494	6,726	1,768		35	3	72	10	2	100	3	1	2	X	X	X		X	X	X	X	X	X	X	X	X
Red Willow	Red Willow	SUA,SRA	5,948	4,320	1,628		100	4	64	20	3	80	4	1	1	X	X	X		X	X	X	X	X	X	X	X	X
Lincoln	Hansen Mem. Res.	SUA	80	79	1		1	1																				X
	Wellfleet	SUA	164	115	49		2	2	9					1	1	X		X				X		X	X	X		X
Chase	Enders	SRA,SUA	5,350	3,643	1,707		30	4	53	30	4	100	4	1	5	X	X	X		X	X	X	X	X	X	X	X	X
	Wanamaker	SUA	160	160																								X
	Champion	SRA	13	2	11		2	1	8	2	2	8		1	1	X		X		X		X			X	X	X	X
	Champion Mill	SHP	4	4																								
Dundy	Rock Creek	SRA,F	215	140	75		5	1	15	5	2	12	1	1	1	X		X	X	X		X	X	X	X	X	X	X
	Arikaree	SWA	6	6																								
Hayes	Hayes Center	SUA	119	79	40		20	1	8																			
Hitchcock	Swanson Res.	SRA,SUA	8,931	3,957	4,974		40	4	73	20	2	75	4	1	1	X	X	X		X	X	X	X	X	X	X	X	X
Red Willow	Red Willow Div.	SUA	56	56			1	1	3									X						X	X	X	X	X
	Bartley Div. Dam	SUA	53	53														X						X		X		X
Webster	Republican Valley	SWA	3	3			21	1	5											X						X	X	X
Kearney	Northeast Sac	SUA	40	40																				X				X
Franklin	Limestone Bluffs	SUA	480	480																			X	X				X
	Ash Grove	SUA	80	80																			X	X				X
Furnas	Oxford	SUA	23	23																				X				X
	Cambridge Div. Dam	SUA	21	21			1	1	2									X		X								
Harlan	So. Sacramento	SUA	167	85	82																			X	X			X
	S-E Sac.	SUA	174	54	120																			X	X			X
Phelps	Sacramento-Wilcox	SUA	2,240	1,239	1	1,000	1	1	10	1	1	15						X		X				X	X	X	X	X
	W. Sacramento	SUA	320	43		277																		X	X			X
Subtotal			33,141	21,408	10,456	1,277	240	25	322	88	16	390	16	7	12													
Federal Areas		Agency																										
Kearney	Wetlands (9 Areas)	USFWS	2,714	1,484		1,230																		X	X			
Franklin/ Phelps	Wetlands (6 Areas)	USFWS	2,835	1,955		880																		X	X			
Harlan	Harlan County Dam	CE	30,280	16,580	13,700		165	17	420	88	7	1,040	5	2	4	X	X	X		X	X	X			X	X	X	X
Gosper	Wetlands (3 Areas)	USFWS	1,451	866		585																		X	X			X
Subtotal			37,280	20,885	13,700	2,695	165	17	420	88	7	1,040	5	2	4													
Total			70,421	42,293	24,156	3,972	405	42	742	176	23	1,430	21	9	16													

1/ SUA - Special Use Area
SWA - State Wayside Area
SHP - State Historic Park
SRA - Special Recreational Area
F - Fisheries
USFWS - United States Fish and Wildlife Service
CE - Corps of Engineers
Source: Nebraska Game and Parks Commission

2/ WW - warm water
CW - cold water
P - power
NP - nonpower
BG - big game
SG - small game
WF - waterfowl

TABLE IV-24 PRIVATE RECREATION RESOURCES
Republican River Basin, Nebraska

Item	Number	Accommodations	Area
Camping - Day	1	50 Guests	5 Acres
Camping - Resident	2	10 Guests	20 Acres
Camping - Transient	1	12 Guests	2 Acres
Shooting Range	3	11 Positions	--
Golf Course	10	9 Hole Each	638 Acres
Golf-Driving Range	1	8 Positions	10 Acres
Parks (Zoo)	2	--	15 Acres
Swimming (Beach)	2	--	4,520 Sq. Ft.
Fishing Enterprises	3	50 Guests	12 Acres
Fishing - Ponds/Lake	8	--	118 Surface Acres
Hunting - Total	9	--	57,866 Acres
- Small Game	4	--	57,420 Acres
- Big Game	1	--	2,000 Acres
- Waterfowl	5	--	466 Acres
Racing - Car	3	4,700 Spectators	27 Acres
Historical/Archeological	7	--	4 Acres
Vacation - Ranch	1	20 Guests	1,000 Acres

Source: National Association of Conservation Districts "Private Sector Recreation Inventory", 1974.

TABLE IV-25 MUNICIPAL OUTDOOR RECREATION RESOURCES
Republican River Basin, Nebraska

Item	Unit	Amount
Area:		
Land	Acre	1,193
Water	Acre	67
Picnicking:		
Area	Acre	103
Sites	Number	48
Tables	Number	583
Fire Grates	Number	78
Shelters	Number	29
Camping:		
Area	Acre	15
Sites	Number	12
Sports and Playfields:		
Area	Acre	429
Playgrounds	Number	122
Playground Pieces	Number	491
Ballfields	Number	61
Horseshoe Courts	Number	9
Basketball Courts	Number	35
Tennis Courts	Number	32
Golf:		
Area	Acre	240
Courses	Number	8
Pools:		
Area	Sq. Ft.	113,444
Swimming Pools	Number	22
Wading Pools	Number	22

Source: Compiled from Nebraska State Comprehensive Outdoor Recreation Plan, 1973.

Wildlife Resources

In times past, the primary type of natural vegetation over most of the basin was a vast expanse of Kansas mixed prairie. Sandsage prairie, shortgrass prairie, flood plain prairie and forest, eastern deciduous forest and wetlands were also present in portions of the basin. The predominant species of wildlife included buffalo, antelope, elk, deer, beaver, mink, muskrat, various species of waterfowl and shore birds, prairie chicken, sharp-tailed grouse, squirrels, and rabbits.

The conversion of prairie to agricultural uses has produced habitat conditions unlike those observed by early settlers. About 51 percent of the land is now used for crop production and introduced pasture. Native prairie occurs only as small, isolated remnant patches in the eastern portion of the basin with much larger areas found in the north central and west. Forested areas along the rivers and tributaries, combined with farmstead and field windbreaks, totals about 40,000 acres or less than one percent of the total land area. There are 14,137 acres of wetlands remaining. This shift in land uses contributed to the elimination of buffalo, elk and all but a few antelope from the basin. Species more adaptable to farmland habitat now reside in the basin.

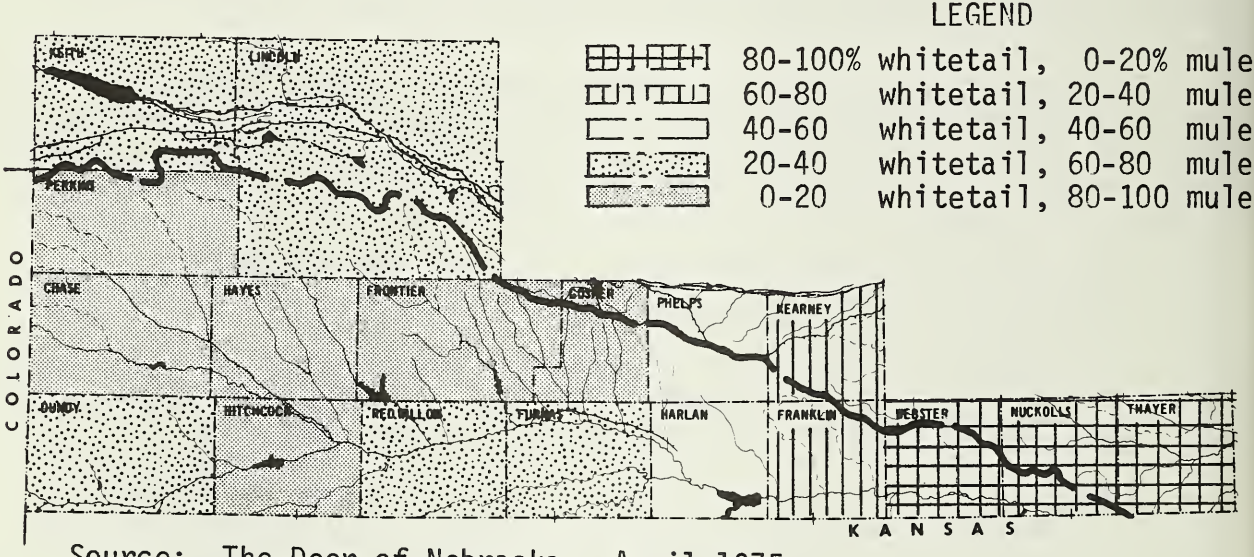
Distributions and relative concentrations of the wildlife species vary throughout the basin and with each species. Habitat quantity and quality are the major factors which control populations. When either is inadequate, disease, starvation, predation, and winter take larger numbers of individuals; successful reproduction declines; and total populations drop to the carrying capacity of the available habitat. Adequate food and cover is especially critical during winter and during reproduction and rearing periods.

Whitetail and mule deer are both found in the basin. The highest deer concentrations (Figure IV-1) occur where croplands are interspersed with or dissected by windbreaks, forest and brushy areas among the fields. Heavily grazed woodlands or brushy areas produce only fair quality habitat.

FIGURE IV-1

Whitetail deer are found most frequently along wooded stream courses in the eastern portion of the basin (Figure IV-2), especially along the Republican River. Even where whitetail numbers are comparatively minor

FIGURE IV-2
DEER SPECIES RANGE



Source: The Deer of Nebraska - April 1975
Nebraska Game and Parks Commission

on a countywide basis, they are often the predominant species in this habitat type. Mule deer also occupy riparian areas along stream courses, but they are generally the more abundant species in the breaks and uplands within the area of major species range overlap such as in the central and western portions of the basin.

The predominant upland game birds found in the basin are the ring-necked pheasant and the bobwhite quail. The ring-necked pheasant is fairly well distributed (Figure IV-3) with the higher numbers in the central portion of the basin where the upland habitat is more diverse.

FIGURE IV-3
RING-NECKED PHEASANT
DENSITY CATEGORIES

MODERATE (25 to 100/Sq. Mi.)
LOW (5 to 25/Sq. Mi.)
SCARCE (Less Than 5/Sq. Mi.)

The highest concentrations of bobwhite quail are found along the wooded stream courses in the eastern and central portion of the basin (Figure IV-4). Very few bobwhite are found in the western end of the basin as suitable habitat is limited, and this is the western boundary for the range of the species.

FIGURE IV-4
BOBWHITE QUAIL
DENSITY CATEGORIES

HIGH (More Than 300/Sq. Mi.)
MODERATE (100 to 300/Sq. Mi.)
LOW (10 to 100/Sq. Mi.)
SCARCE (Less Than 10/Sq. Mi.)
NONE

Ring-necked pheasant and bobwhite quail population trends are illustrated in Figure IV-5. Both populations have declined since their most recent peak in the early and mid 1960's soil bank years. In recent years, many areas that were once devoted to wildlife have been destroyed.

Figure IV-5
PHEASANT AND QUAIL POPULATION TREND
Southwest Nebraska District

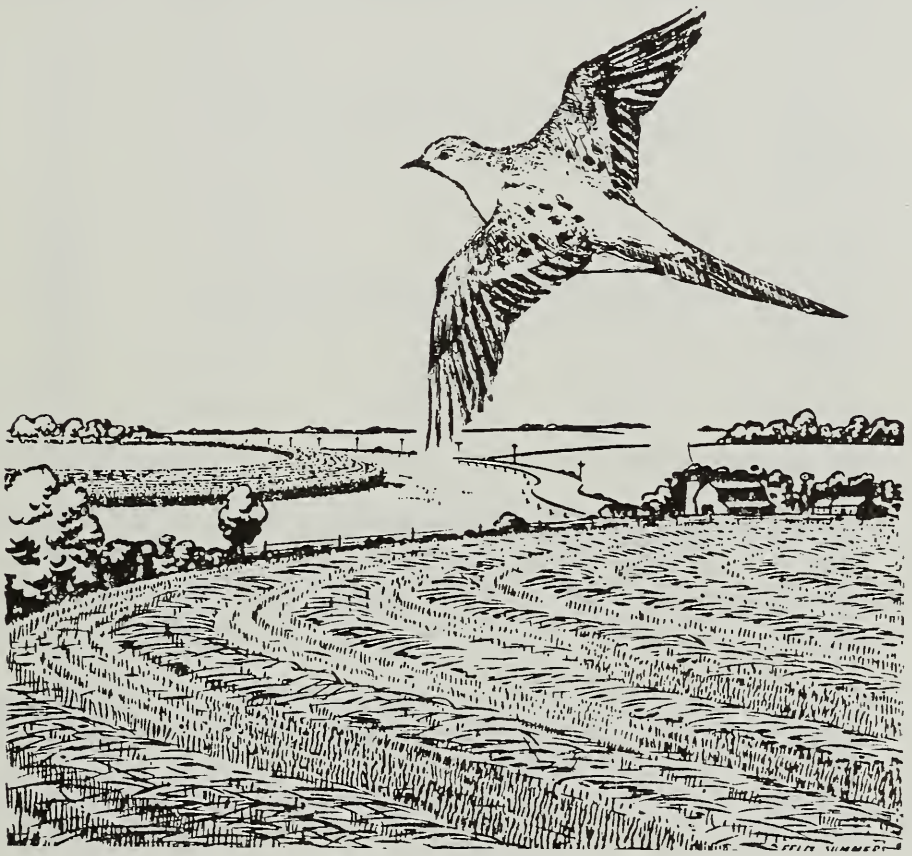
Source: Nebraska Game and Parks Commission

Note: Rural Mail Carriers, Summer Survey for the Southwest District.

Other important species of upland game found throughout the basin include the cottontail rabbit, fox squirrel and mourning dove. The higher concentrations of cottontails are in the eastern and central portions of the basin where woody and shrubby habitat comes in contact with cropland (Figure IV-6).

FIGURE IV-6
COTTONTAIL RABBIT
DENSITY CATEGORIES

Fox squirrels are generally limited to the bottomland woodlands along the Republican River and its major tributaries. The mourning dove, a migratory upland game bird, inhabits the entire basin,and its numbers have increased. Doves have only been hunted in Nebraska since 1975 and appear to be gaining in popularity. Dove hunting has not reached its potential and should supply many hunting opportunities in the future.



Doves Are Numerous Throughout the Basin

Wildlife upland habitat of varying quality totals 190,383 acres throughout the basin. Table IV-26 gives a breakdown of the different types of upland habitat by county. Excellent habitat is provided on approximately 54,555 upland acres; about one-half of this is within State and Federal management areas, generally in association with large reservoirs or wetlands. The other one-half is on private lands devoted to wildlife. Windbreaks, roadside ditches, field borders and stream-banks and adjacent woodland provide the remaining habitat.

The basin contains a small number of wetlands (Table IV-27). These wetlands are located in two areas: one is the sandhills of Chase, Perkins, Keith, and Lincoln Counties; the other is the rainwater basin which overlaps into the river basin in parts of Franklin, Gosper, Harlan,

TABLE IV-26 WILDLIFE UPLAND HABITAT (1976)
Republican River Basin, Nebraska

County[1]	Roadsides & Rail-road ROW	Grassed Waterways & Channels	Odd Areas Devoted to Wildlife[2]	Designated Wildlife Areas (Private, State & Federal)	Streambanks & Adjacent Woodlands[3]	Field Borders & Windbreaks	Critical Area Plantings	Total Upland Habitat
	(Acres)							
Chase	1,696	396	5,000	4,457	557	1,515	809	14,430
Dundy	1,592	530	1,000	176	1,865	1,469	821	7,453
Franklin	2,060	394	90	2,188	2,020	484	406	7,642
Frontier	2,915	497	7,200	10,300	735	2,387	111	24,145
Furnas	2,656	924	4,550	44	13,744	619	177	22,714
Gosper	1,090	219	217	985	618	1,463	37	4,629
Harlan	2,295	662	2,500	17,069	8,757	3,017	464	34,764
Hayes	1,364	197	4,800	317	375	1,570	995	9,618
Hitchcock	1,953	390	4,800	4,082	1,765	785	137	13,912
Kearney	296	259	36	1,534	46	501	21	2,693
Keith	68	9	36	0	0	36	48	197
Lincoln	622	67	3,800	244	110	295	252	5,390
Nuckolls	648	970	1,736	100	1,208	241	84	4,800
Perkins	2,809	205	1,116	11	45	642	263	5,277
Phelps	1,043	1,343	86	1,686	191	1,752	89	6,190
Red Willow	2,150	710	6,200	2,009	5,564	1,327	675	18,635
Thayer	8	6	0	0	0	1	1	16
Webster	1,139	1,354	1,023	3	2,521	1,358	579	7,877
Total	26,404	9,132	44,190	45,205	40,021	19,462	5,969	190,383

Source: USDA, Soil Conservation Service.
1/ Upland habitat is for that part of county which is in the basin.
2/ Center pivot corners, ox-bows, wildlife land, etc.
3/ Based on U.S. Forest Service estimates and Economics, Statistics & Cooperatives Service data.

TABLE IV-27 WETLANDS
Republican River Basin, Nebraska

County	Types 1 and 2 1/		Type 3 1/		Types 4 and 5 1/	
	(Number)	(Acres)	(Number)	(Acres)	(Number)	(Acres)
Chase	93	2,118	0	-	12	163
Franklin	6	163	8	1,590	0	-
Gosper	8	145	2	55	4	513
Harlan	-	-	3	123	1	124
Kearney	7	121	6	582	2	148
Keith	136	503	0	-	7	116
Lincoln	232	866	0	-	17	58
Perkins	1,248	3,936	276	1,290	0	-
Phelps	16	765	0	-	4	962
Total	1,746	8,617	295	3,640	47	2,084

Source: Nebraska Game & Parks Commission Survey of Habitat. P.R. Project W-15-R-28, March 1, 1971 to February 29, 1972.

1/ Types 1, 2, 3, 4, and 5 wetlands as defined in USDI Fish & Wildlife Circular 39, "Wetlands of the United States".

Type 1 - Seasonally Flooded Basins or Flats, the period of inundation is such that the land can usually be used for agricultural purposes.

Type 2 - Inland Fresh Meadows, the soil usually is without standing water during most of the growing season but is waterlogged within at least a few inches of its surface.

Type 3 - Inland Shallow Fresh Marshes, the soil is usually waterlogged during the growing season; often it is covered with as much as six inches or more of water.

Type 4 - Inland Deep Fresh Marshes, the soil is covered with six inches to three feet or more of water during the growing season.

Type 5 - Inland Open Fresh Water, shallow ponds with water levels of less than 10 feet deep and is fringed by a border of emergent vegetation.

Kearney and Phelps Counties. The sandhills wetlands have not suffered very much at the hands of agricultural drainage. Since historic times, the number of wetlands has only been reduced by one percent and acreage by 15 percent. In the Rainwater Basin where soils and slopes are more conducive to agriculture, extensive drainage has taken place. According to Nebraska Game and Parks Commission research, the number of wetlands has been reduced by 82 percent and acreage reduced by 65 percent. The most common species of waterfowl found in these areas include mallard, pintail, blue and green-winged teal. Numerous other species of waterfowl and shore birds are present, especially during spring and fall migration.

Fishery Resources

Five large reservoirs provide the bulk of the quality fishing opportunity in the basin. These reservoirs provide 23.8 thousand surface acres and a wide variety of game fish including white bass, large-mouth bass, northern pike, walleye, channel catfish, bullheads, white and black crappie, and numerous species of sunfishes. However, these reservoirs are declining in fishing quality principally because of high rough-fish populations, high turbidities and untimely reservoir drawdowns that also limit game fish production.

Rivers and creeks provide 993 miles of flowing water throughout the basin. Three streams provide cold water fisheries with a potential for improvement. Several other streams could become cold water fisheries with proper management. The remaining streams provide a warm water habitat of various qualities. The majority sustain only a minnow fishery or high rough-fish populations. Rainbow and brown trout occur in the three cold water streams. Channel catfish, large-mouth bass, crappies, northern pike, and white bass inhabit the better warm water streams. Carp and other rough-fish have invaded most of the streams and many of the lakes. Stream fishery habitat has decreased due to reduced stream-flows, high rough-fish populations, high turbidity and periodic flooding.

Threatened and Endangered Species

Some species have not been able to adjust to environmental change. Species considered threatened or endangered that may be seen in the basin include the bald eagle, whooping crane, greater sandhills crane, American peregrine falcon, black footed ferret, and swift fox. The status of these and other species is periodically reviewed and updated by the Nebraska Game and Parks Commission and the U.S. Fish and Wildlife Service.

Bald eagles are winter migrant visitors along the eastern portion of the Republican River and around Harlan County Reservoir. As many as 70 bald eagles have been counted near the Harlan County Reservoir and

along the Republican River just below the dam during the winter months. The bald eagle is listed as an endangered species by the Nebraska Game and Parks Commission and by the Federal government.

Archeological and Historical Resources

The Republican River Basin is rich in archeological, historical and cultural resources. There are 54 archeological sites in the basin that are listed in the Nebraska State Historical Society publication entitled "Historic Preservation in Nebraska", Preservation Report No. 1. These sites are predominately of prehistoric and historic aboroginal vintage.

There is no record of the first man in the plains, but the Cheyenne Indians claim that their ancestors, fleeing now-forgotten enemies, crossed salt water in the frozen regions far to the north before reaching the plains. These men learned to live along streams like Lime and Medicine Creeks in Frontier County -- streams that have probably existed since the first glaciers. Paleo Indian and Forager materials dating 5000 to 9000 B.C. were recorded to have been found at the Lime Creek site.

Some time between 400 and 600 A.D., a Woodland culture arose in Nebraska. Primarily hunters, they may have cultivated some crops. By about 1200 A.D., they had disappeared or merged into an Upper Republican people who spread in large, earthen villages from the Republican Valley to the Loup country. These people were apparently more dependent on agriculture than their predecessors, and as new influences and new people pushed up from the south, they developed more artistic abilities, forming high-grade pottery and stone, bone, horn, and shell ornaments.

Although the majority of the sites verified are cultural remains of ancient Indian villages, such sites as a pioneer cemetery, ancient Indian burial grounds, seasonal shelters, ancient quarries, and rifle pits can be found within the basin. Even though all sites within the basin play an important role in its history, some have been designated as having greater significance. Those holding this honor have been declared National Historical Landmarks. The Federal Register, National Register of Historic Places, lists nine sites within the basin significant enough to be so designated (see Table IV-28). One such site located in southeastern Webster County near the town of Guide Rock, is the Pike Pawnee Village site. Here, at the request of Lt. Zebulon M. Pike (better remembered for the expedition during which he lost his life to the mountain now known as Pike's Peak, Colorado), an American flag was raised to replace a Spanish flag marking the end of Spanish authority on the northern Great Plains.

Another site, the Massacre Canyon Battlefield, is found in Hitchcock County three miles northeast of Trenton, Nebraska. On August 5, 1873, a hunting expedition of approximately 700 Pawnee Indian men, women and

TABLE IV-28 ARCHEOLOGICAL AND HISTORICAL ASPECTS
Republican River Basin, Nebraska

County/Item[1]	Significance		
	Archeological	Architectural	Cultural
Chase			
Champion Mill			X
Fox Williams (PA); Ough Site (PA); Lovitt Site (PA)[2]	X		
Dundy			
General Custer-Pawnee Killer Encounter (HA)	X		X
Nichols Site (PA)	X		
Franklin			
Copley Site (PA), Ted Hill Site (PA); Lost Creek Site (PA)	X		
Milo Hill Site (PA)	X		
Frontier			
County Court House		X	
Pioneer Cemetery	X		X
Allen Site (PA); Bridgeford Site (PA); Dick Site (PA); Gammill Site (PA); Lime Creek Site (PA); Mousel Site (PA); Owens Site (PA); Keith Site (PA); Red Smoke Site (PA)[2]; Spring Creek Site (PA); Thompson Farm Site (PA); 25FT70 (PA); 15FT95 (PA); Mowry Bluff Site [2]	X		
Furnas			
Log Cabin		X	
Norris House; Schoolhouse			X
Site 25FN9 (PA); 25FN15 (PA); 25FN21 (H); 25FN22 (PA); Flodine Site (PA)	X		
Gosper			
Site 26GO30 (PA)	X		
Harlan			
Culbertson Grave Site; Judge William Gaslin Homestead; Pioneer Crossion			X
Graham Ossuary (PA); Marshall Ossuary (PA); Orleans Ossuary (PA); Alma Ossuary (PA); Stevenson Village (PA); White Cat Village (PA); Site 25HN39 (PA); Site 25HN45 (PA)	X		
Hayes			
Duke Alexis Camp Site			X
Estelle Post Office		X	
Forrest Beebe Site (PA); Hahn Site (PA); Horn Site (PA)	X		
Hitchcock			
Stone Church		X	
Massacre Canyon Battlefield (HA)[2]	X		X
Massacre Canyon Site (PA); Carmody Site (PA); Ross Site (PA)	X		
Kearney			
No known aspects within basin area			
Keith			
No known aspects within basin area			
Lincoln			
No known aspects within basin area			
Nuckolls			
Union Hotel; Log Cabin; Round Barn		X	
Perkins			
No detailed surveys as of 1971			
Red Willow			
Fitch House; Sutton House; Polyhedral Barn		X	
Norris House[2]		X	X
Doyle Site (PA)[2]; Red Willow Site (PA); 25RW22 (PA)	X		
Thayer			
No known aspects within basin area			
Webster			
Burlington Depot; Willa Cather Childhood Home[2]; Cather Pioneer Memorial Bldg.; Commercial Bldgs.		X	X
Catholic Church; Maple Grove Church; Starke Barn[2]		X	
Guide Rock; Miner House; Webster County Historical Museum Bldg.; Red Could Stockade Site			X
Pike Pawnee Willage Site (HA)[2]	X		X
Pike Rifle Pits; Shipman Site (P/HA); Wolfe Site (PA); Guide Rock Ossuary (PA); Robb Ossuary (PA)	X		

Source: As verified in "Historic Preservation in Nebraska", Nebraska State Historical Society Preservation Series, Report No. 1, 1971.

1/ PA = Prehistoric Aboriginal; HA = Historic Aboriginal and H = Historic.

2/ Sites which appear on the list of National Register of Historic Places, Federal Register.

children were attacked by a group of Sioux. The Pawnee fighting men were outnumbered four to one and soon retreated down the canyon. It was during this retreat that the greatest loss of life occurred among the women and children, the Sioux riding down each side and firing on them. As the Pawnee reached the river, a company of U.S. Cavalry emerged from the timber,and the Sioux turned and fled. In 1931, with appropriations by the U.S. Congress, a 35-foot high granite monument was erected in memory of this last Sioux-Pawnee battle. This marker was the first Federally granted historical monument erected in Nebraska.

The Lovitt site is found in Chase County, 16 miles northeast of Imperial along Stinking Water Creek. It is one of the type sites included in the Dismal River Aspect which dates from 1675 to 1700 and represents a pottery-making Protohistoric (period immediately preceding recorded history) group often associated with the northern Apache.

The Republican River Basin has an abundance of impressive structures known for their architecturally historic importance. Such structures as log cabins, churches, commercial buildings, courthouses, barns, houses, a post office, and a depot provide the basin with active interest and display of a past heritage kept alive.

There are two structures that are especially interesting in their construction. The first, located near the village of Hamlet, Nebraska, in Hayes County is the Estelle Post Office. This two-story building is completely structured of native stone. The facade consists of two stone walls, one inside the other, with an air space filled with pebbles, producing a structure with 30-inch walls. This building has served as a post office, a home and a general store. A second unique structure, the Starke Barn, is the largest round barn in Nebraska and may well be the largest in the United States. It is located directly south of Amboy Junction between Red Cloud and Guide Rock in Webster County. It is circular and 130 feet in diameter. The main support contains no nails, spikes or pegs -- the framework being held together by tenons. Two other round barns are located within the basin.

Another structure listed on the National Register of Historic Places is the Norris House in McCook. George Norris grew up in Nebraska and went on to become a U.S. Senator. With the Tennessee Valley Authority dams proving themselves, he decided that something could be done about the uncertainties of sufficient rainfall in Nebraska. He argued in Congress for a similar project in southwest Nebraska. From his and other efforts, Enders, Swanson, Red Willow, and Medicine Creek Reservoirs, irrigation and flood control impoundments, have changed the character of the land surrounding them as does Harlan County Reservoir on the Republican River. Senator Norris' house, erected in 1886 and purchased in 1899, is a modest, two-story structure in the "Queen Anne" style, with numerous gables. Stucco replaced the original siding in 1931. Norris occupied the house until his death in 1944. Today the house stands as a monument to a great man and fine politician.

There appears to be a fine link joining the architectural history with the cultural history in the basin. An excellent example of this union can be seen in Webster County, specifically in and around the city of Red Cloud. It is within this area that Willa Cather, outstanding music and drama critic as well as world famous novelist, spent her childhood to young womanly years. She immortalized such places as the Burlington Depot, the Opera House and the Miner House, as well as a group of commercial buildings. The Willa Cather Childhood Home has been enrolled on the National Register and is the most important building in Nebraska associated with her distinguished career.

An 1872 event which deserves mentioning because of its international significance occurred near the present town of Culbertson in Hayes County. It was here that the last notable wild buffalo hunt in America took place. As part of Russia's earnest desire to cement its friendship, Duke Alexis visited the United States. Part of his visit included this buffalo hunt led by Buffalo Bill Cody, a legendary figure of the west. It is also noted as the only royal hunt ever to have taken place in the United States.

McCook and Riverton, Two Thriving Communities in the Republican Basin

CHAPTER V
PROBLEMS AND CONCERNS

Water and land resource problems and development opportunities which affect the basin are identified and discussed in this chapter. Analyses of problems describes causes, extents, frequencies, and social and economic consequences. Analyses, when possible, are in physical and monetary terms. Other problems are identified and analyzed whose solutions would result in economic growth, increased production efficiency or general enhancement of the physical environment.

Erosion

Accelerated erosion is a serious problem on some classes of soil in the Republican Basin. Accelerated erosion can best be defined as erosion occurring more rapidly than the natural or geologic erosion; primarily as a result of the influence of the activity of man. On cultivated fields, tillage reduces the vegetative cover and exposes the soil, thus reducing its resistance to flowing water. Overuse of grazing lands has increased soil erosion as a result of reduction in the vegetative cover. Erosion by water averages over 35 million tons annually. Cultivation of sandy soils has accelerated the erosion of soil by wind. Wind erosion results in removal of varying thicknesses of soil depending on the degree of exposure to the wind.

Sheet and Rill Erosion

Sheet and rill erosion is often referred to as soil loss. Thirty-one (31) percent or 1.9 million acres of the basin has been identified

Sheet and Rill Erosion Carry Away Valuable Top Soil

as being adequately treated against soil loss (Table V-1). Land that has been adequately treated refers to agricultural land with proper vegetative, mechanical and/or management practices applied to obtain an acceptable soil loss tolerance control and an optimum production potential. An additional 3.0 million acres has been identified as being adequately protected. Land adequately protected refers to agricultural land that is protected from water and wind erosion so that soil loss rates are within the soil erosion tolerance established for a specific soil. The soil erosion rates on 82 percent of the agricultural land in the basin are within soil loss tolerances. However, there are about 1.1 million acres of land that have soil loss rates in excess of acceptable soil loss tolerances. Nearly all of this area, about 900 thousand acres, is cropland.

The soil loss from sheet and rill erosion in the basin is 30.5 million tons annually, averaging 4.9 tons per acre for all land (Table V-2). However, the annual soil losses of all cropland, both irrigated and nonirrigated, amount to over 20 million tons, averaging about 7 tons per acre. This accounts for two-thirds of the total soil loss from sheet and rill erosion in the basin. A major proportion of cropland soil loss occurs on less than one-third of the cropland. The largest acreage, 406 thousand, is classified as IIIe land, which is neither adequately treated or protected (Table V-3). Soil losses on these lands annually amount to 3.5 million tons, an average of 8.6 tons per acre. Class IVe lands, 271 thousand acres, sustain soil losses at an even higher rate, averaging 12.4 tons per acre, or a total of 3.4 million tons. The greatest soil loss rates per acre occur on Class VIe and VIIe lands without adequate treatment or protection, with losses averaging 37.7 and 64.8 tons per acre annually. Annual soil losses amount to 8.0 million tons on 213 thousand acres of VIe land and 65 thousand tons on one thousand acres of VIIe land.

The sheet and rill erosion rates per acre are higher in the eastern part of the basin (below Harlan County Reservoir) averaging 8.1 tons of soil loss per acre. All sources of soil loss average about 9.7 tons per acre in this area. Much of the lower part of the basin is rolling to gently rolling. The watersheds in the upper end of the basin have the lowest erosion rates, some averaging less than 3 tons per acre annually, due to large acreages of sandy soils with high intake rates, a high proportion of range and pasture, and lower amounts of annual precipitation.

All of the pasture and rangeland is adequately protected from soil losses except for 183 thousand acres of Class VII lands. These lands are distributed throughout the basin. Some occur at the upper end of the gullies where headcuts have intruded into the tablelands. Other areas are so steep that vegetation has not established good cover, while other areas may be affected by slides.

TABLE V-1 CURRENT STATUS OF CONSERVATION TREATMENT
Republican River Basin, Nebraska

Land Class	Total Acres	Adequately Treated	Adequately Protected	Needs Treatment	Needs Protection
	(Acres Thousands)				
Cropland (Nonirr. & Irr.)					
I	283.3	110.4	283.3	172.9	0
II	1,616.8	492.6	1,616.8	1,124.2	0
III	556.1	124.4	153.8	431.7	402.3
IV	354.6	68.4	76.5	286.2	278.1
V	.4	.4	.4	0	0
VI	246.8	8.4	30.5	238.4	216.3
VII	2.1	0	0	2.1	2.1
Subtotal	3,060.1	804.6	2,161.3	2,255.5	898.8
Pasture & Range					
I	5.7	1.1	5.7	4.6	0
II	224.2	66.3	224.2	157.9	0
III	110.8	36.9	110.8	73.9	0
IV	261.8	100.6	261.8	161.2	0
V	4.8	3.0	4.8	1.8	0
VI	1,897.0	617.8	1,897.0	1,279.2	0
VII	317.5	121.6	133.3	195.9	184.2
VIII	.2	0	.2	.2	0
Subtotal	2,822.0	947.3	2,637.8	1,874.7	184.2
Forest & Woodland	40.0	40.0	40.0	0	0
Other Agri. Land	97.8	95.8	97.8	2.0	0
TOTAL	6,019.9	1,887.7	4,936.9	4,132.2	1,083.0
Percent	100	31	82	69	18

Note: Land "Adequately Treated" refers to agricultural lands with proper vegetative, mechanical and/or management practices applied to obtain an acceptable soil loss tolerance control and a optimum production potential. Land "Adequately Protected" refers to agricultural lands that are protected from water and wind erosion so that soil erosion rates are within the soil erosion tolerance established for a specific soil.

Roadside Erosion

Erosion affects about 200 miles of roadsides. The amount of sediment produced has been included in the gully and streambank soil loss estimates.

TABLE V-2 AVERAGE ANNUAL GROSS SOIL LOSS
Republican River Basin, Nebraska

Watershed No.	Name	Drainage Area (Acres)	Sheet Erosion (Thousand Tons)	Gully Erosion (Thousand Tons)	Bank Erosion (Thousand Tons)	Gross Erosion (Thousand Tons)	Ave. Ann. Soil Loss (Tons/Ac.)
41a3-1	Sand Creek	67,800	174.1	3.5	3.5	181.1	2.7
-4	Frenchman R. (Enders Reservoir)	164,400	421.0	21.1	21.1	463.2	2.8
41a -1	Chase-Dundy Sandhills	123,900	299.3	9.0	3.0	311.3	2.5
-2	Indian Creek	100,000	240.9	12.0	24.1	277.0	2.8
-3	Burntwood Creek	67,200	208.5	20.9	20.9	250.3	3.7
-4	Muddy Creek (Dundy Co.)	95,100	259.1	25.9	25.9	310.9	3.3
-5	Culbertson to Stratton Tribs. (North)	71,500	309.4	15.5	30.9	355.8	5.0
-6	Culbertson to Stratton Tribs.(South)	90,300	391.6	39.2	39.2	470.0	5.2
41a1-8	N. Fork Rep. R.	14,600	33.5	3.4	5.0	41.9	2.9
-10	Buffalo Creek	82,100	189.4	9.5	9.5	208.4	2.5
-11	Rock-Spring Creeks	180,200	417.9	20.9	20.9	459.7	2.6
-12	Hay Canyon-etc. Tribs.	26,300	60.3	6.0	6.0	72.3	2.8
41a1(a)-8	Arikaree River	8,300	18.8	1.9	2.8	23.5	2.8
41a2-13	S. Fork Rep. R.	3,900	9.4	1.4	1.9	12.7	3.3
41a -11	Red Willow Cr.(Upper)	272,000	809.4	40.5	40.5	890.4	3.3
-12	Red Willow Cr.(Lower)	235,200	1,269.5	63.5	127.0	1,460.0	6.2
41a3(a)-1	Venango Tribs.	38,100	109.4	2.2	2.2	113.8	3.0
-2	Spring Creek (Upper)	113,300	339.9	13.6	6.8	360.3	3.2
-3	Grant Tribs.	147,400	490.0	19.6	9.8	519.4	3.5
-4	Stinking Water Cr.(Upper)	231,000	739.5	22.2	29.6	791.3	3.4
-5	Stinking Water Cr.(Lower)	148,600	536.8	26.9	26.9	590.6	4.0
41a3-5	Frenchman R. (Wauneta Tribs)	102,600	363.1	18.2	36.3	417.6	4.1
-6	Frenchman R. (Lower)	131,400	565.8	28.3	56.6	650.7	5.0
-7	Upper Blackwood	99,900	459.8	23.0	23.0	505.8	5.1
-8	Blackwood Cr.	187,700	907.7	45.4	90.8	1,043.9	5.6
41a6-4	Prairie Dog Cr.(Lower)	40,300	268.2	13.4	13.4	295.0	7.3
41a5-6	Sappa Creek	17,100	116.5	5.8	5.9	128.2	7.5
-7	Sappa Creek (Lower)	119,300	835.6	42.1	42.1	919.8	7.7
-8	Stamford	2,900	8.0	0.1	0.1	8.2	2.8

(continued)

TABLE V-2 (Continued)

Watershed No.	Name	Drainage Area (Acres)	Sheet Erosion (Thousand Tons)	Gully Erosion (Thousand Tons)	Bank Erosion (Thousand Tons)	Gross Erosion (Thousand Tons)	Ave. Ann. Soil Loss (Tons/Ac.)
41a5a-6	Beaver Creek	14,300	64.8	3.2	3.2	71.2	5.0
-7	Beaver Creek (Lebanon)	125,600	634.1	31.7	31.7	697.5	5.6
-8	Beaver Creek	129,400	908.6	45.5	45.4	999.5	7.7
41a4-1	Medicine Cr.(Sandhills)	230,200	695.5	34.8	69.6	799.9	3.5
-2	Medicine Cr. (Upper)	219,100	840.9	84.1	100.9	1,025.9	4.7
-3	Medicine Cr. (Lower)	152,700	744.9	111.7	111.7	968.3	6.3
-4	Medicine-Mitchell Creeks etc.	83,500	503.5	75.5	75.5	654.5	7.8
41a -7	Driftwood Creek	131,700	580.2	29.0	58.0	667.2	5.1
-8	Dry Creek (South)	22,800	37.2	1.9	1.9	41.0	1.8
-9	McCook Tribs.	52,600	240.1	24.0	24.0	288.1	5.5
-10	Sleepy Hollow-Brushy, etc. Creeks	86,900	394.7	19.7	19.7	434.1	5.0
-13	Coon Creek	60,100	330.6	33.1	17.3	381.0	6.3
-14	Dry Creek (Pilot)	35,400	152.9	7.6	7.6	168.1	4.7
-15	Cambridge to Bartley Tribs. (North)	30,400	165.6	7.6	7.6	180.8	5.9
-16	Silver Creek	30,100	153.5	7.7	7.7	168.9	5.6
-17	Rep. R. South Tribs. (Furnas Co.)	111,300	773.9	38.7	38.7	851.3	7.6
-18	Deer Creek	126,800	695.9	69.6	34.8	800.3	6.3
-19	Muddy Creek (Frontier & Gosper Counties)	161,100	1,009.1	50.5	100.9	1,160.5	7.2
-20	Elk-Turkey,etc. Creeks	205,800	1,359.3	68.0	68.0	1,495.3	7.3
-21	Orleans Tribs.	250,000	1,519.7	76.0	152.0	1,747.7	7.0
-22	Turkey Creek	106,200	718.0	71.8	71.8	861.6	8.1
-23	Lost Creek, etc.	54,100	403.0	20.2	40.3	463.5	8.6
-24	Sacramento Tribs.	76,700	338.0	16.9	16.9	371.8	4.9
-25	Center-etc. Tribs.	99,100	757.0	75.7	75.7	908.4	9.2
-26	Thompson Creek	191,600	1,311.0	131.1	131.1	1,573.2	8.2
-27	Lohff -Oak-etc. Creeks	84,800	696.0	69.6	69.6	835.2	9.9
-28	Farmers-Indian-etc.Creeks	77,500	646.0	64.6	64.6	775.2	10.0
-29	Red Cloud Tribs.	95,800	797.0	119.6	79.7	996.3	10.4
-30	Minnie Creek	6,500	59.0	5.9	8.9	73.8	11.4
-31	Courtland Tribs.	35,000	382.0	19.1	38.2	439.3	12.6
-32	Superior Tribs.	146.000	1,746.0	174.6	174.6	2,095.2	14.4
60	TOTALS	6,215,500	30,510.4	2,144.0	2,473.3	35,127.7	5.7

Note: Watersheds listed in sequence used for sediment routing.

TABLE V-3 AGRICULTURAL LANDS WITH EXCESSIVE EROSION - CURRENT
Republican River Basin, Nebraska

Class & Sub-Class	Total			Adequately Treated			Needing Treatment or Protection		
	Acres	Tons	T/Ac.	Acres	Tons	T/Ac.	Acres	Tons	T/Ac.
	---(Thos.)---			--(Thos.)--			---(Thos.)---		
Cropland (Nonirr. & Irr.)									
IIIe	521.0	3,552.4	6.8	114.5	81.4	0.7	406.5	3,483.9	8.6
IVe	337.1	3,455.4	10.2	65.6	88.5	1.3	271.5	3,366.8	12.4
VIe	220.8	8,017.2	36.3	8.3	12.5	1.5	212.5	8,016.7	37.7
VIIe	1.0	65.0	64.8	0.0	0.0	0.0	1.0	65.0	64.8
VIIs	1.1	7.7	7.3	0.0	0.0	0.0	1.1	7.7	7.3
Sub-total	1,081.0	15,097.7	14.0	188.4	182.4	1.0	892.6	14,940.2	16.7
Pasture & Range									
VII-e	302.1	2,205.1	7.3	119.0	368.8	3.1	183.1	1,812.6	9.9
TOTAL	1,383.1	17,302.8	12.5	307.4	551.2	1.8	1,075.7	16,752.8	15.6

Gully Erosion

Modern gully erosion ranges from slight in the western part of the basin to moderately severe in parts of the eastern portion of the basin.

Gullies Destroy Crop and Rangeland

There are many gullies and canyons throughout the basin, particularly in the area north of the Republican River. In past times, erosion cut long fingers into the relatively flat areas of tableland, creating gullies and canyons with an elevation differential of 50-100 feet between the tableland plateaus and the canyon bottoms. However, most of these features are now effectively stabilized and have broad grassed bottoms except in a few areas where runoff water is eroding a small channel through the bottoms of these ancient features.

Frequently, there is a small, moderately active headcut at the point where the gully enters the tableland which continues to destroy or adversely affect prime farmland. There is sufficient erosion activity in gullies to annually produce 2.1 million tons of soil loss in the basin or 6 percent of the total soil loss from all causes (Table V-2).

Streambank Erosion

Streambank erosion is considered moderate to moderately severe in the basin. Many of the channels have semi-stabilized banks, protected by stringers of trees and other vegetation. A few streams have sections where streambank erosion and bankcutting is severe. There are approximately 115 miles of streambanks with moderate to severe erosion rates. It is estimated that annual soil loss from streambank erosion is about 2.5 million tons (Table V-2), approximately 7 percent of the amount of total soil loss in the basin.

Sediment Effects

Delivery and deposition of sediment are major water resource problems in the basin. Sediment impairs recreation by causing turbidity and "mud flats", interferes with aquatic habitat by depositing fine sediments and displaces water storage capacity in reservoirs which reduces storage capacity.

Although the sheet and rill erosion process produces 30.5 million tons or 87 percent of the soil losses in the basin, only 10 percent or 3.1 million tons is yielded as stream sediment at the mouth of the watersheds (Table V-4). Sheet and rill erosion occurs on all the land, much of which is far from stream courses and watershed mouths. In the transportation process, much of the soil loss is deposited at field slope changes, fence rows, tree lines, bottom lands, and in farm ponds. In the basin, this results in a yield of about 10 percent of the total sheet and rill erosion as sediment to the watershed mouths.

On the other hand, soil losses from gully and bank erosion occur in streambanks or in gullied areas and deliver a high percentage of the eroded products into the stream course. Gully erosion yields about 50 percent or 1.1 million tons to stream sediment at watershed mouths.

TABLE V-4 SEDIMENT YIELDS BY WATERSHED
Republican River Basin, Nebraska

Watershed Number. Name	Sediment Source: Delivery Ratio: Sheet & Rill	Gully	Bank	Ave. Ann. Yield: Sheet & Rill	Gully	Bank	Bedload	Total Ave. Ann. Yield
	(Percent)			(Tons Thousands)				
41a3-1 Sand Creek	8	40	40	13.9	1.4	1.4	0.7	17.4
-4 Frenchman R. (Enders)	9	40	45	37.9	8.4	9.5	5.7	61.5
41a -1 Chase-Dundy Sandhills	6	45	45	18.0	4.0	1.4	-	23.4
-2 Indian Cr.	14	45	45	33.7	5.4	10.8	2.7	52.6
-3 Burntwood Cr.	15	45	55	31.3	9.4	11.5	4.7	56.9
-4 Muddy Cr. (Dundy)	11	50	50	28.5	13.0	13.0	2.9	57.4
-5 Culbertson-Stratton Trib North	12	55	50	37.1	8.5	15.5	5.7	66.8
-6 Culbertson-Stra. Trib So.	12	50	55	47.0	19.6	21.6	7.1	95.3
41a1-8 No. Fork Rep.R.	13	55	65	4.4	1.9	3.3	0.9	10.5
-10 Buffalo Cr.	8	45	50	15.2	4.3	4.8	1.5	25.8
-11 Rock-Spring Cr.	9	45	45	37.6	9.4	9.4	3.8	60.2
-12 Hay Canyon,etc. Tribs	19	55	55	11.5	3.3	3.3	1.7	19.8
41a1 (a)-8 Arikaree R.	16	55	55	3.0	1.0	1.5	0.5	6.0
41a2-13So. Fork Rep. River	19	60	60	1.8	0.8	1.1	0.5	4.2
41a-11 Red Willow Cr. (Upper)	7	40	50	56.7	16.2	20.3	5.7	98.9
-12 Red Willow Cr. (Lower)	7	50	50	88.9	31.8	63.5	13.3	197.5
41a3 (a)-1 Venango Tribs	7	40	40	7.7	0.9	0.9	0.2	9.7
-2 Spring Cr. (Upper)	4	40	40	13.6	5.4	2.7	0.7	22.4

(continued)

TABLE V-4 (continued)

Watershed Number	Name	Sediment Source: Delivery Ratio: Sheet & Rill (Percent)	Delivery Ratio: Gully (Percent)	Delivery Ratio: Bank (Percent)	Ave. Ann. Yield: Sheet & Rill (Tons Thousands)	Ave. Ann. Yield: Gully (Tons Thousands)	Ave. Ann. Yield: Bank (Tons Thousands)	Ave. Ann. Yield: Bedload (Tons Thousands)	Total Ave. Ann. Yield
41a3									
(a)-3	Grant Tribs	3	40	40	14.7	7.8	3.9	0.7	27.1
-4	Stinking Water Cr.(Upper)	4	40	40	29.6	8.9	11.8	2.1	52.4
-5	Stinking Water Cr.(Lower)	5	50	50	26.8	13.5	13.5	2.7	56.5
41a3-5	Frenchman R. (Wauneta)	10	50	50	36.3	9.1	18.2	5.5	69.1
-6	Frenchman R. (Lower)	8	50	50	45.3	14.2	28.3	6.8	94.6
-7	Upper Blackwood	5	50	50	23.0	11.5	11.5	2.3	48.3
-8	Blackwood Cr.	6	50	40	54.5	22.7	36.3	5.5	119.0
41a6-4	Prairie Dog Cr. (Lower)	10	50	55	26.8	6.7	7.4	2.7	43.6
41a5-6	Sappa Creek	15	50	50	17.5	2.9	3.0	1.8	25.2
-7	Sappa Cr.(Lower)	12	50	55	98.8	20.6	22.7	14.8	156.9
-8	Stamford	25	50	50	5.0	0.5	0.5	0.5	6.5
41a									
5a-6	Beaver Cr.	14	50	50	9.1	1.6	1.6	1.4	13.7
-7	Beaver Cr. (Lebanon)	14	50	55	88.8	15.9	17.4	13.3	135.4
-8	Beaver Cr. (Beaver City)	12	55	50	109.0	25.0	22.7	16.4	173.1
41a4-1	Medicine Cr. (Sandhills)	6	55	60	41.7	19.1	38.3	4.2	103.3
-2	Medicine Cr. (Upper)	11	60	65	92.5	50.5	65.6	13.9	222.5
-3	Medicine Cr. (Lower)	10	60	65	74.5	67.0	72.6	11.2	225.3
-4	Medicine-Mitchell Crs. etc.	11	60	65	55.4	45.3	49.1	8.3	158.1
41a -7	Driftwood Cr.	12	50	50	69.6	14.5	29.0	10.4	123.5
-8	Dry Cr.(So.)	12	50	50	4.5	0.9	0.9	0.7	7.0
-9	McCook Tribs	12	50	50	28.8	12.0	12.0	2.9	55.7

(continued)

TABLE V-4 (continued)

Watershed Number	Name	Sediment Source: Delivery Ratio: Sheet & Rill (Percent)	Gully (Percent)	Bank (Percent)	Sediment Source: Ave. Ann. Yield: Sheet & Rill (Tons Thousands)	Gully (Tons Thousands)	Bank (Tons Thousands)	Bedload (Tons Thousands)	Total Ave. Ann. Yield (Tons Thousands)
41a-10	Sleepy Hollow Etc. Crs.	13	45	50	51.3	8.9	9.9	5.1	75.2
-13	Coon Creek	10	50	55	31.6	15.8	8.7	6.3	62.4
-14	Dry Creek (Pilot)	12	50	50	21.9	4.6	4.6	3.3	34.4
-15	Cambridge to Bartley Trib (North)	10	50	50	15.1	3.8	3.8	2.3	25.0
-16	Silver Creek	10	45	50	15.4	3.5	3.9	1.5	24.3
-17	Rep.R.South Tribs(Furnas Co.)	12	45	55	92.9	17.4	21.3	18.6	150.2
-18	Deer Creek	7	50	50	48.7	34.8	17.4	7.3	108.2
-19	Muddy Creek	9	45	55	90.8	22.7	55.5	18.2	187.2
-20	Elk-Turkey etc. Cr.	9	45	50	122.3	30.6	34.0	18.3	205.2
-21	Orleans Trib	10	50	50	152.0	38.0	76.0	22.8	288.8
-22	Turkey Cr.	13	50	55	93.3	35.9	39.5	18.7	187.4
-23	Lost Cr-etc. Tribs	17	55	55	68.5	11.1	22.2	10.3	112.1
-24	Sacramento Tribs	9	40	40	30.4	6.8	6.8	1.5	45.5
-25	Center-etc. Tribs	13	50	60	98.4	37.9	45.4	24.6	206.3
-26	Thompson Cr.	8	50	60	104.9	65.6	78.7	26.2	275.4
-27	Lohff-Oak etc. Crs.	15	55	55	104.4	38.3	41.8	15.7	200.2
-28	Farmer-etc. Crs.	13	50	60	84.0	32.3	38.8	16.8	171.9
-29	Red Cloud Tribs	13	50	55	103.6	59.8	43.8	25.9	233.1
41a-30	Minnie Cr.	22	55	60	13.0	3.2	5.3	4.6	26.1
-31	Courtland Tribs	15	50	55	57.3	9.6	21.0	11.5	99.4
-32	Superior Tribs	15	55	55	261.9	96.0	96.0	65.5	519.4
	TOTAL				3101.7	1091.5	1336.2	511.4	6040.8

In a similar manner, 1.3 million tons or 55 percent of the bank erosion is yielded. An additional 0.5 million tons of stream sediment are classified as bedload. Table V-4 shows the stream sediment yield to mouths of watersheds by source.

Sediment Effects on Reservoirs

Most of the sediment and bedload carried in the stream are delivered to and retained in the major reservoirs in the basin (Table V-5). About 5 percent of the deliveries to these reservoirs is estimated to pass on through the spillway and add to the sediment load downstream. The smallest load is delivered to Enders Reservoir, amounting to only

TABLE V-5 AVERAGE ANNUAL SEDIMENT DELIVERIES TO SELECTED POINTS
Republican River Basin, Nebraska

Area	Delivered To 1/		Trapped By	Passed 1/
	(Tons/Year)			
Hugh Butler Lake	197,600		187,700	9,900
Harry Strunk Lake	528,500		502,100	26,400
Enders Reservoir	73,500		69,800	3,700
Swanson Lake	520,800		494,800	26,000
Harlan County Lake	1,862,500		1,788,000	74,500
		Total	3,042,400	
Nebraska-Kansas Border Below Superior, NE	1,520,800		--	1,520,800

1/ Noncumulative

73,500 tons annually. The largest amount is delivered to Harlan County Lake averaging about 1.9 million tons each year. Total sediment trapped in these reservoirs amounts to over 3 million tons annually. In addition, 1.5 million tons of sediment annually are carried by the Republican River out of Nebraska into Kansas. Nearly all of this amount originates in the tributaries discharging directly into the Republican River below the Harlan County Reservoir. Sediment deliveries to lakes or reservoirs in the basin are filling them at rates lower than anticipated in the reservoir designs. Published sedimentation surveys on Harlan County Reservoir, Harry Strunk Lake and Enders Reservoir by the Bureau of Reclamation and Corps of Engineers indicate that sediment is presently accumulating at rates below those predicted in sediment storage designs for these structures.

Sediment Effects on Streams

Since closure of Harlan County Reservoir, the lack of periodic flushing action by flood flows has allowed sediment and vegetation to accumulate in some stretches of the channel. Many landowners and operators on the mainstem bottom land below the reservoir are seriously concerned about diminishing capacity of the mainstem channel. They claim that, in the years since closure of the reservoir, capacity of the channel has been reduced due to sediment accumulation, extensive vegetative growth along the banks and bars, and local debris dumping into the channel. Loss of capacity would increase the possibilities of damaging floods occurring along the mainstem.

Sediment Deposits Reduce Channel Capacity

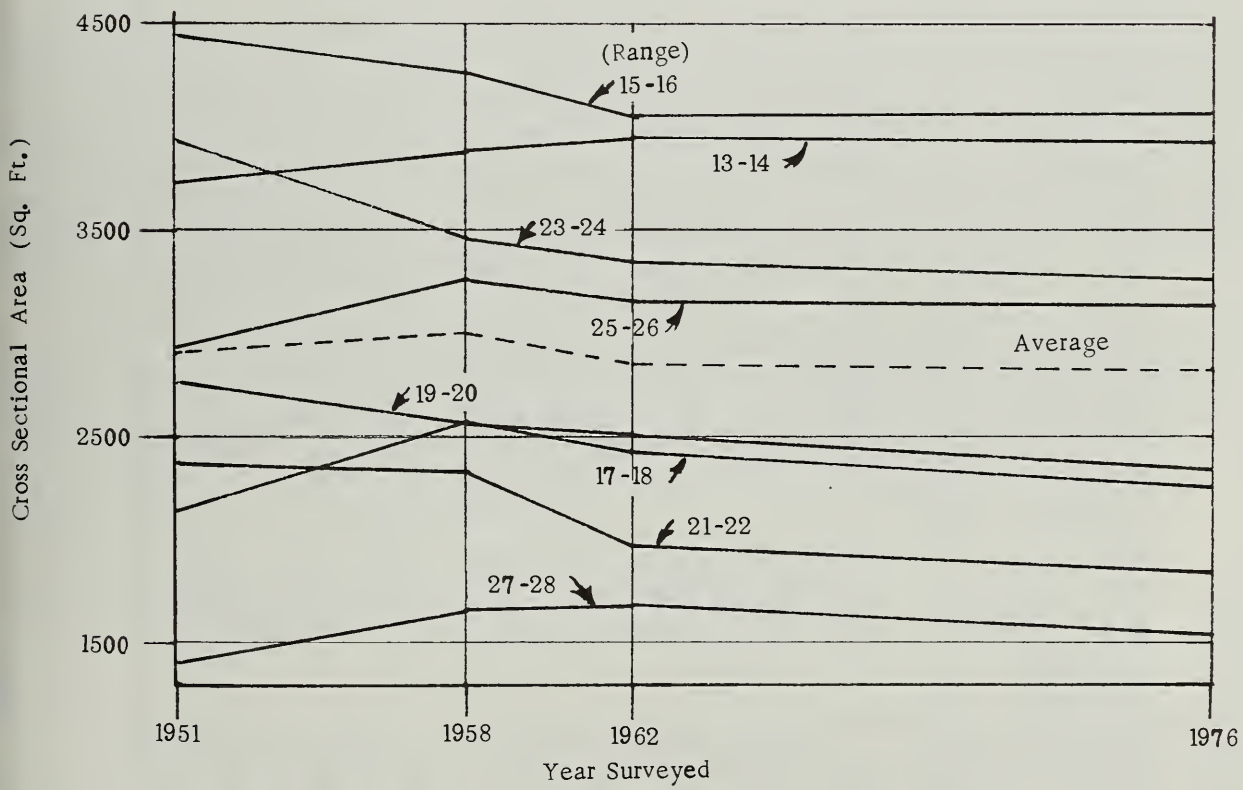
Due to this continuing concern, study of the channel capacities has occurred periodically. In a 1963 report, the Corps of Engineers stated that the primary cause of reduced channel capacity in this stretch of the Republican River was the extensive vegetal growth along the channel banks and on island bars. Since 1963, the vegetative effect on channel flow has apparently changed very little. Later study has concentrated more on the effects of sediment on channel capacities.

As part of their post-construction monitoring procedures, the Corps of Engineers established a series of 14 degradation ranges on the Republican River from just below Harlan County Dam to Superior, Nebraska. They were monitored by the Corps periodically through 1963, and a number of them were resurveyed in 1972. In 1976, the SCS reestablished eight of the ranges, surveyed the cross-sections and compared the results of all the surveys (Figure V-1 and Table V-6). Although four cross-sections showed percentage increases in area, and four showed percentage decreases, the surveys showed the 26-year net channel loss in cross-sectional area of the eight ranges studied to be 5 percent.

FIGURE V-1

CROSS SECTIONS OF RIVER CHANNEL BELOW HARLAN CO. DAM

(Corps of Engineers Degradation Ranges)



Source: Sedimentation In Harlan County Reservoir, Corps of Engineers, July 1963
1976 Survey-SCS, Water Resources Staff, Lincoln, Nebraska

The sediment source causing this reduction in channel cross-sectional area is primarily influx into the channel from tributary watersheds. The main contributors appear to be watersheds on the north side of the channel, such as Turkey, Center and Thompson Creeks. Sediment accumulation also may be accelerated locally by outwash from some of the approximately 45 active, inactive or abandoned sand and gravel operations in this part of the basin.

TABLE V-6 SELECTED RIVER DEGRADATION RANGES BELOW HARLAN COUNTY RESERVOIR
Elevation and Cross-Sectional Area
Republican River, Nebraska

Item		River Bottom Elevation (M.S.L.) and Change from 1951 Elevation (-) Degrade (+) Aggrade				Datum Elevation (M.S.L.) 1/	Channel Cross-Section Area and Changes from 1951 (-) Decrease (+) Increase				Channel X-Section of 1951
Range	River Mile	1951	1958	1962	1976		1951	1958	1961	1976	
		(feet)					(square feet)				(Percent)
Reservoir	239.4										
13-14	227.2	1,823.5	1,821.2 -2.3	1,822.6 -0.9	1,822.5 -1.0	1,839.3	3,726	3,890 +164	3,952 +226	3,922 +196	105
15-16	224.6	1,806.6	1,806.9 +0.3	1,807.0 +0.4	1,808.4 +1.8	1,823.2	4,436	4,287 -149	4,069 -367	4,080 -356	92
17-18	221.9	1,798.3	1,799.7 +1.4	1,799.3 +1.0	1,800.4 +2.1	1,807.6	2,138	2,589 +451	2,424 +286	2,285 +147	107
19-20	215.0	1,772.6	1,771.5 -1.1	1,770.6 -2.0	1,772.2 -0.4	1,782.6	2,755	2,554 -201	2,503 -252	2,345 -410	85
21-22	208.5	1,746.5	1,746.0 -0.5	1,746.6 -0.1	1,748.1 +1.6	1,756.9	2,383	2,312 -71	1,988 -395	1,863 -520	78
23-24	190.6	1,668.3	1,670.1 +1.8	1,671.7 +3.4	1,672.3 +4.0	1,683.8	3,933	3,473 -460	3,362 -571	3,283 -650	83
25-26	177.7	1,620.0	1,620.2 +0.2	1,619.1 -0.9	1,618.4 -1.6	1,630.0	2,935	3,275 +340	3,155 +220	3,144 +209	107
27-28	160.1	1,552.4	1,554.9 +2.5	1,555.7 +3.3	1,556.3 +3.9	1,565.2	1,410	1,678 +268	1,691 +281	1,542 +132	109

1/ Datum Elevation - Base elevation used for cross-sectional area determinations.
Source: Data for years 1951, 1958, and 1962, Corps of Engineers, Kansas City, Missouri;
1976 data - Nebraska Water Resources Planning Staff, Soil Conservation Service.

The problems of vegetal growth and actual physical reduction of channel cross-sectional area due to sediment accumulation are primary causes of reduced channel capacity. As stated in the 1963 Corps report, vegetal growth is considered the major cause, although both problems are interrelated.

Reduction in channel capacity due to sedimentation problems is not a major concern in other portions of the basin.

Nutrient Content of Sediment

Erosion is not only the movement of soil particles, but it also includes the movement and loss of plant nutrients from the crop and pasturelands of the basin. The economic consequences of this nutrient removal are lost food and fiber production and lower quality crops. Also, increased production costs result from fertilizer applications to help restore the nutrient balance of the soils.

Nutrients removed from basin lands also contribute to nutrient pollution of lakes, streams and ground water. Cultural practices intensify this problem because increased erosion rates or fertilizer application are usually associated with cultivation of the land. Nitrogen and phosphorus are the principal nutrients released by cultivation that accompany sediments. If there is erosion on soil that has nitrogen and phosphorus tied to the colloidal fractions of the soil, these nutrients will be carried to the streams and lakes.

Sufficient cultivation occurs in the basin to make nutrient content of delivered sediment a present concern and a potential future problem. Under present conditions, approximately 4,360 tons of nitrogen and 323 tons of phosphorus are estimated to be entering watercourses in the basin annually. This results in amounts delivered to selected points in the basin as shown in Table V-7.

TABLE V-7 NUTRIENT DELIVERIES TO SELECTED POINTS
Republican River Basin, Nebraska

Selected Points	Nitrogen Delivered	Phosphorus Delivered
	(Ave. Ann. Tons)	
Hugh Butler Lake	69.2	4.9
Harry Strunk Lake	281.3	19.1
Enders Reservoir	25.9	0.3
Swanson Lake	150.4	9.5
Harlan County Lake	1,368.3	103.3
Nebraska-Kansas Border Below Superior, NE	1,541.3	117.8

Pivot Irrigation Development

Self-propelled pivot sprinkler irrigation systems have provided a mechanical means of applying water uniformly to rolling land as well as to level land. Some of the pivot systems are able to climb slopes much above ten percent. These mechanical capabilities have allowed irrigation development on soils with high erodability and have accelerated or brought about deterioration of the soil resources in some instances. The conversion of rangeland to irrigated cropland has exposed some soils to accelerated erosion hazards. The wheel tracks have become eroded, and small gullies have formed from the runoff from irrigation water. "Blow-outs" have also occurred in coarse sandy soils that have little or no cohesiveness.

Conservation Treatment and Management is Needed on the Land Irrigated by Pivot Systems

A special survey was made of the agricultural lands and irrigated soils in Dundy, Chase, Perkins, and parts of Keith Counties to determine the seriousness of this problem. As three of these counties do not have soil surveys, a special survey was conducted wherein the soils in the entire area were mapped for irrigation suitability. Criteria used to classify the soils were as follows:

Group A Lands have slight limitations for sustained irrigation. They are nearly level or gently sloping with 0 to 3 percent gradients and have deep rooting zones, favorable intake rates, high water holding capacity, and good tilth. The surface relief is such that there are no restrictions to the operation of farm equipment, including self-propelled sprinkler irrigation equipment. Water distribution can be accomplished with minimal or no land shaping. Both surface and subsurface drainage are adequate and impose no limitations or only slight limitation to efficient water use and management.

Group B Lands have moderate limitations or sustained irrigation; however, they have characteristics that make them less suitable than those in Group A. Included in this group are lands with the following characteristics: 3 to 6 percent slope, deep rooting zones, favorable intake rates, high water holding capacities, and good tilth. These lands are similar to those in Group A but differ principally in having: higher slope gradients, nearly level to gentle slopes (0 to 3 percent), deep rooting zones, favorable water holding capacities, and slow intake rates; 0 to 6 percent slopes, moderately deep to shallow rooting zones, moderate to low water holding capacities, and good intake rates; and 0 to 6 percent slopes, deep rooting zones, medium to low water holding capacities, and high intake rates (2.0 inches per hour or higher). Surface relief is such that there are no restrictions to the operation of farm equipment including self-propelled sprinkler irrigation equipment. Both surface and subsurface drainage may impose slight to moderate limitations to efficient water use and management.

Group C Lands have severe limitations for sustained irrigation. They have one or more adverse characteristics, which, for sustained irrigation, require intensive cultural and irrigation management measures. Included in this group are lands with the following characteristics: 6 to 10 percent slopes, deep rooting zones, favorable intake rates, and water holding capacities that are easily maintained in good tilth; 3 to 6 percent slopes, deep rooting zones, high water holding capacities but slow intake rates; 6 to 10 percent slopes, shallow to moderately deep rooting zones and good intake rates; 6 to 10 percent slopes and high intake rates (2.0 inches per hour or higher); and 0 to 1 percent slopes, deep to moderately deep rooting zones with very slow permeability. These soils generally have poor soil moisture-plant relationships, poor tilth or soil structure. They are subject to salt accumulation.

Group D Lands have very severe or unsatisfactory limitations. Soils in this group have one more characteristic that makes them generally unsatisfactory for sustained irrigation. Included are soils with excessive slopes, stony or rocky soils, presence of excess water, presence of excess amounts of soluble salts, and overflow hazards.

Delineation of soil irrigability groups were generalized so that any plot contained at least 40 acres. Exceptions were made for drainageways or extreme topographic changes which would make irrigation impossible or extremely difficult. Results of this survey of the 1.9 million acres in this area (Table V-8) show that over 1.1 million acres or 55 percent of the land to be in Groups A and B, 26 percent and 19 percent were in Groups C and D, respectively.

The cropping pattern for May, 1975, was secured from a high level flight made as a part of the ground water study in the area. This study was made by the Conservation Survey Division, University of Nebraska, in cooperation with the U.S. Geological Survey for the Upper Republican Natural Resources District. This flight showed that 77 percent of the area irrigated fell in Group A and B, 19 percent in Group C, and only 4 percent, or less than 10,000 acres, was classified as Group D.

Well registration records, Nebraska Department of Water Resources, were used to establish the 1965 irrigation pattern. The May, 1965, irrigation pattern was confirmed by interviews with agricultural workers and others with long term experience in the area. The results indicated that at the time, that 87 percent, a higher proportion than exists today, of the irrigated land was Groups A and B. Group C land irrigated has increased from 11 percent to 19 percent, and the Group D from 2 percent to 4 percent. These figures confirm the concern of the local people that there has been an increase in the irrigation of the less desirable land. However, the problem, although serious, is not as widespread as some random estimates. A significant proportion of these lands with high hazards is isolated or contained within an area of more desirable land. Seldom will an irrigation area be entirely comprised of Group D soils. Nevertheless, the erosion on Group C and, particularly, on Group D lands is serious, and high level management as well as mechanical and vegetative conservation practices must be exercised to keep erosion rates within acceptable tolerances. Some areas should be returned to permanent cover.

Impaired Drainage

Drainage needs are dependent on the desired use of the areas having impaired drainage problems. The potential economic return to the landowners and operators, as well as the size of the affected area, will usually determine the use.

From the total 238,700 acres having impaired drainage, 32,200 acres have been identified in the Nebraska Conservation Needs Inventory, 1969, as having the kinds and extent of problems for project size action. Of this amount, 37 percent of 11,900 acres was estimated to be cropland. The Bureau of Reclamation, in connection with their basin irrigation projects, has constructed approximately 80 miles of drains to improve impaired drainage on 7,400 acres of irrigated and nonirrigated cropland. An additional ten miles of drains are planned for installation to control wetness problems on an additional 1,000 acres for a total of 8,400 acres.

TABLE V-8 AGRICULTURAL LAND USE BY IRRIGATION SUITABILITY GROUP
UPPER REPUBLICAN LAND AND WATER STUDY AREA
Republican River Basin, Nebraska

Land Use	Irrigation Group	Total (Ac.)	(%)	Dundy (Ac.)	(%)	Chase (Ac.)	(%)	Perkins (Ac.)	(%)	Keith (Ac.)	(%)
Agri-cultural Land 1975	A	459,766	25	98,344	17	125,602	22	172,112	31	63,708	34
	B	567,955	30	124,223	21	139,230	25	246,847	44	57,655	31
	C	492,662	26	231,930	40	115,150	21	103,961	19	41,621	23
	D	355,864	19	125,829	22	177,214	32	31,185	6	21,636	12
Total		1,876,247	100	580,326	100	557,196	100	554,105	100	184,620	100
(May 1975 Cropping Pattern)											
Irrigated Row Crop	A	74,198	33	14,787	28	31,447	34	13,653	28	14,311	51
	B	97,761	44	22,708	43	41,621	45	23,892	49	9,540	34
	C	41,979	19	13,731	26	13,873	15	10,727	22	3,648	13
	D	8,182	4	1,584	3	5,549	6	488	1	561	2
Total		222,120	100	52,810	100	92,490	100	48,760	100	28,060	100
Irrigated Forage Crops	A	10,370	28	1,960	26	3,333	23	2,483	32	2,594	39
	B	15,641	43	2,714	36	6,665	46	3,802	49	2,460	37
	C	8,768	24	2,564	34	3,333	23	1,475	19	1,396	21
	D	1,661	5	302	4	1,159	8	0	0	200	3
Total		36,440	100	7,540	100	14,490	100	7,760	100	6,650	100
Irrigated Land 1975	A	84,568	33	16,747	28	34,780	33	16,136	28	16,905	49
	B	113,402	44	25,422	42	48,286	45	27,694	49	12,000	34
	C	50,747	19	16,295	27	17,206	16	12,202	22	5,044	15
	D	9,843	4	1,886	3	6,708	6	488	1	761	2
Total		258,560	100	60,350	100	106,980	100	56,520	100	34,710	100
(May 1965 Cropping Pattern)											
Irrigated Land 1965	A	31,297	43	8,411	42	8,448	35	3,072	50	11,366	52
	B	31,641	44	7,961	40	12,698	52	2,739	44	8,243	37
	C	8,012	11	3,430	17	1,971	8	358	6	2,253	10
	D	1,536	2	179	1	1,152	5	0	0	205	1
Total		72,486	100	19,981	100	24,269	100	6,169	100	22,067	100

The remaining acres within project action size areas are not considered feasible for project action for several reasons. Many of the areas are classified in land capability classes IVw, Vw and VIw where project actions are not recommended. A substantial portion of these areas are wetlands which provide valuable wildlife habitat. Other areas are being or could be treated by on-farm drainage measures.

Other than those areas identified for project action drainage improvement by the Bureau of Reclamation, no additional drainage project areas were identified by local public groups, Natural Resource Districts or other agencies.

Floodwater Damages

Floods in the basin are caused by a variety of events. Chief among them are the floods resulting from short duration, high intensity thunderstorms, often referred to as "flash floods" because of the speed with which the discharge rises and falls. Ice jams occasionally cause severe local flooding and damage bridges and other flood plain installations. It is estimated that about 117,300 acres in the basin are subject to flooding by a 100-year frequency flood. This represents about two percent of the land area (Table V-9).

Flood damage to crops and pasture varies widely, depending largely on the characteristics of the flood but also on the maturity of the crop. Damage involves such factors as time of year, depth and duration of inundation, velocity of flow, and sediment content. Reductions in net income occur because of lower yields, additional tillage, weed control requirements, replanting costs, delayed plantings, and additional fertilizer costs.

Irrigation canals and ditches may be filled with sediment and debris, and structures such as drops, turnouts and siphons are often left inoperative when flood runoff flows reach the gently sloping to level irrigated areas. Sediment and debris deposited on the fields interfere with irrigation, smother young crops, and sometimes require releveling of fields. If a disrupted irrigation system cannot be repaired readily, partial or even complete crop loss can result from lack of irrigation water, especially if the weather later on in the growing season becomes hot and dry.

Average annual crop and pasture damages are estimated to be $1,280,700.

Other agricultural damage includes floodwater and sediment damage to fences, harvested crops, stored grain, machinery, and livestock. Included also is the expense of recovering strayed animals and the

Disastrous floods have occurred on the Republican River over the past century. Legend recalls a flood of record magnitude in 1866 and major floods occurring in 1915, 1923 and 1935. The latter flood had a crest discharge of 280,000 second-feet at Cambridge, Nebraska, on May 31, 1935. Downstream the crest flattened, and the peak was 168,000 second-feet at the mouth on June 3, 1935. This flood took a toll of 105 lives and did damage estimated at that time in excess of $9 million according to the Corps of Engineers Review Report, Republican River, May, 1963.

Photo Credit: High Plains Museum, McCook, Nebraska

TABLE V-9 SUMMARY OF CURRENT FLOODWATER AND SEDIMENT DAMAGES
Republican River Basin, Nebraska

Watershed Number	Watershed Name	Drainage Area (Acres)	Area 1/ Needing Project Action (Acres)	Average Annual Damage (Dollars)					
				Crop & Pasture	Other AGR.	Rural Non-AGR.	Urban	Indirect	Total
41a-1	Chase Dundy Sandhills	123,900	1,100	2,700	300	0	0	300	3,300
41a-2	Indian Creek	100,000	950	11,400	1,100	3,300	0	1,800	17,600
41a-3	Burntwood Creek	67,200	600	4,800	500	2,400	0	900	8,600
41a-4	Muddy Creek (Dundy Co.)	95,100	900	14,400	1,400	3,200	0	2,100	21,100
41a-5	Culbertson to Stratton Tribs (N)	71,500	500	4,000	400	3,400	1,500	1,200	10,500
41a-6	Culbertson to Stratton Tribs (S)	90,300	400	4,400	400	2,400	0	900	8,100
41a-7	Driftwood Creek 5/	131,700	2,342	35,000	3,500	17,500	0	6,700	62,700
41a-8	Dry Creek (South) 6/	22,800	2,300	18,900	1,800	1,200	0	2,300	24,200
41a-9	McCook Tribs	45,200	1,500	15,000	1,500	1,500	2,200	2,400	22,600
	Kelly Creek	7,400	100	800	0	0	0	100	900
41a-10	Sleepy Hollow, Brush, etc. Creeks	86,900	800	9,600	2,000	7,800	0	2,400	21,800
41a-11	Red Willow Creek (Upper)	272,000	2,100	8,400	2,300	4,200	0	1,800	16,700
41a-12	Red Willow Creek (Lower)	235,200	1,960	19,600	5,600	3,600	0	3,300	32,100
41a-13	Coon Creek 5/	60,100	864	26,300	2,600	11,600	0	5,000	45,500
41a-14	Dry Creek (Pilot) 6/	35,400	1,750	18,900	1,900	2,600	0	2,600	26,000
41a-15	Cambridge to Bartley Tribs (N)	30,400	300	3,900	400	3,600	0	1,200	9,100
41a-16	Silver Creek	30,100	250	2,000	1,000	1,900	0	600	5,500
41a-17	Republican River South Tribs (Furnas)	111,300	700	5,900	600	7,800	0	1,900	16,200
41a-18	Deer Creek	126,800	1,450	5,100	2,900	6,600	0	1,900	16,500
41a-19	Muddy Creek (Frontier & Gosper)	161,100	1,900	5,700	600	19,800	0	3,600	29,700
41a-20	Elk-Turkey, etc. Creeks	205,800	2,900	15,300	4,500	34,800	0	7,400	62,000
41a-21	Orleans Tribs	238,300	4,600	27,600	2,800	16,800	0	5,600	52,800
	Milrose Creek 5/	11,700	812	19,400	1,900	5,300	0	3,100	29,700
41a-22	Turkey Creek 5/	106,200	2,336	37,300	3,700	20,900	800	7,600	70,300
41a-23	Lost Creek, etc. Tribs.	54,100	600	3,600	400	8,500	0	1,700	14,200
41a-24	Sacramento Tribs.	76,700	3,100	1,300	100	6,400	0	1,100	8,900
41a-25	Center, etc. Tribs	99,100	1,250	7,500	800	16,500	0	3,300	28,100
41a-26	Thompson Creek	191,600	3,800	34,200	3,400	14,500	1,400	6,400	59,900
41a-27	Lohff - Oak, etc. Creeks	84,800	1,650	5,600	600	20,500	0	3,700	30,400
41a-28	Farmers, Indian, etc. Creeks	77,500	2,750	19,400	1,900	30,500	0	6,800	58,600
41a-29	Red Cloud Tribs	95,800	1,300	8,200	800	24,000	1,800	4,900	39,700
41a-30	Minnie Creek	6,500	100	2,800	300	1,500	1,300	800	6,700
41a-31	Courtland Tribs.	35,000	250	1,800	200	6,000	0	1,100	9,100
41a-32	Superior Tribs.	146,000	2,600	24,700	2,500	39,300	8,200	10,400	85,100
41a1-8	North Fork Republican River 2/	14,600	200	300	100	300	0	100	800
41a1-10	Buffalo Creek	82,100	200	1,600	200	0	0	200	2,000
41a1-11	Rock Spring Creeks 5/	180,200	600	1,200	100	0	6,400	1,400	9,100
41a1-12	Hay Canyon, etc. Tribs	26,300	200	1,700	200	400	0	300	2,600

TABLE V-9 (continued)

Watershed Number	Watershed Name	Drainage Area (Acres)	Area 1/ Needing Project Action (Acres)	Average Annual Damage (Dollars) Crop & Pasture	Other AGR.	Rural Non-AGR.	Urban	Indirect	Total
41a1(a)-8	Arikaree River 3/	8,300	0	0	0	0	0	0	0
41a2-13	South Fork Republican River 4/	3,900	0	0	0	0	0	0	0
41a3-1	Sand Creek	67,800	3,000	17,200	1,700	2,400	0	2,100	23,400
41a3-4	Frenchman River (Enders Reservoir)	164,400	2,300	6,900	700	6,000	0	900	14,500
41a3-5	Frenchman River (Wauneta Tribs)	102,600	1,545	5,700	600	1,300	21,800	5,200	34,600
41a3-6	Frenchman River (Lower)	131,400	5,120	57,000	5,700	4,500	0	2,100	69,300
41a3-7,8	Blackwood Creek 6/	287,600	5,700	26,100	1,600	3,800	0	3,400	34,900
41a3(a)-1	Venango Tribs.	38,100	500	2,000	1,200	1,800	0	600	5,600
41a3(a)-2	Spring Creek (Upper)	113,300	1,000	4,000	400	600	0	600	5,600
41a3(a)-3	Grant Tribs	147,400	1,000	4,000	400	0	0	500	4,900
41a3(a)-4	Stinking Water Creek (Upper)	231,000	2,750	7,600	3,800	6,000	0	2,200	19,600
41a3(a)-5	Spring -Stinking Water Creeks (Lower)	148,600	5,040	36,800	3,700	5,700	0	5,100	51,300
41a4-1	Medicine Creek (Sandhills)	230,200	1,680	1,700	200	0	0	200	2,100
41a4-2	Medicine Creek (Upper) 6/	219,100	2,595	15,400	3,300	4,700	0	2,700	26,100
41a4-3	Medicine Creek (Lower) 6/	152,700	3,974	54,200	10,500	4,900	0	7,700	77,300
41a4-4	Medicine Creek (Includes Mitchell Creek)	83,500	300	1,200	100	0	0	100	1,400
41a5-6	Sappa Creek	17,100	170	200	100	2,400	0	400	3,100
41a5-7	Sappa Creek (Lower)	119,300	9,000	185,000	18,500	24,000	0	24,900	252,400
41a5-8	Stamford Creek 6/	2,900	410	3,400	300	600	0	500	4,800
41a5(a)-6	Beaver Creek	14,300	0	0	0	1,000	0	200	1,200
41a5(a)-7	Beaver Creek (Lebanon)5/	125,600	7,900	175,200	17,500	31,500	800	24,200	249,200
41a5(a)-8	Beaver Creek (Beaver City) 5/	129,400	9,237	204,800	20,500	36,900	0	28,100	290,300
41a6-4	Prairie Dog Creek (Lower)	40,300	2,100	42,000	4,200	4,800	0	5,600	56,600
	TOTAL	6,215,500	117,335	1,280,700	150,300	493,500	46,200	226,200	2,196,900

1/ Area needing project action is defined as flood plain adjacent to tributary stream courses inundated by the 100 yr. storm.
2/ D. A. in Nebraska Common flood plain affected by tributaries is 200 ac. (total flood plain area - Mainstem 2600 ac.)
3/ D. A. in Nebraska Common flood plain affected by tributaries is zero ac. (total flood plain area - Mainstem 1200 ac.)
4/ D. A. in Nebraska Common flood plain affected by tributaries is zero ac. (total flood plain area - Mainstem 750 ac.)
5/ Watersheds selected for intensive study.
6/ PL-566 Watersheds approved for installation of structural measures. Only remaining damages listed for these watersheds.
Note: Price Base: Current Normalized Prices (July 1976) for agricultural damages, 1975 prices for other damages.

damage done by those animals to crops. Farmsteads and lots are generally located above the flood plain, and, therefore, are usually free of flood damage. It is estimated that the average annual other agricultural damage is $150,300.

Flood damages to county and local roads usually are greater than to the more heavily constructed State and Federal highways. County bridges are less likely to withstand large floods. The undermining of the bridge abutments and supports causes many bridges to collapse or wash out. The most frequent damage to railroad facilities involves bridges, culverts and roadbed fills. Traffic delays and rerouting costs add to the transportation losses. Rural nonagricultural average annual damage is estimated to be $493,500.

Losses occur in urbanized flood plains as a result of water, sediment and debris damage to homes, churches, public buildings, utilities, commercial and industrial businesses, and the contents of each building. Other losses include reduced income and profits because of business disruption, clean-up expenses and the cost of temporary housing. There are 39 urban communities in the basin that have potential for being damaged by floods. Average annual damages for 10 of these communities are estimated to be $46,200 (Table V-10). Estimates were not made for the remaining communities even though there could be damages by large infrequent storms.

Indirect damages are those losses which stem from flooding even though the area or property may not have been flooded and are estimated to be $226,200. Examples included interruptions to travel, necessary rerouting of traffic, temporary dislocation of persons from work, extra time and travel required for delivering farm products, interrupted mail and delivery schedules, and disruption and damage to utility systems.

Residual floodwater and sediment damages under current economic conditions are estimated to average $2,196,900 annually. Table V-9 lists the current residual damage for each delineated watershed.

Water Shortages

The distribution of rain throughout the growing season is generally favorable to the growing of crops. However, as in all other areas in the Great Plains, the climatic variation each year and frequent sustained drought periods and subnormal annual precipitation requires some supplemental water each year for full crop production. Traditionally, irrigation has been used in the basin to increase production in an effort to increase and stabilize income. Since about 1950, however, with higher production costs generally and the need to assure and stabilize individual farm production and income, irrigation has come to be used also as a supplemental water supply in marginal rainfall areas. Monthly and total crop consumptive irrigation requirements based on an average

TABLE V-10 CURRENT AVERAGE ANNUAL URBAN FLOOD DAMAGES
Republican River Basin, Nebraska

Community	1970 Population	Watershed - Name	Average Annual Damages
Arapahoe	1,147	Muddy Creek (Frontier and Gosper)	N
Bartley	283	Dry Creek (Pilot)	N
Beaver City	802	Beaver Creek (Lower)	N
Benkelman	1,349	Rock-Spring Creeks	6,400
Cambridge	1,145	Medicine Creek (Below H. Strunk Lake)	N
Cowles	57	Red Cloud Tribs	N
Culbertson	801	Frenchman River (Lower)	N
Curtis	1,166	Medicine Creek (Upper)	N
Edison	199	Elk-Turkey, Etc. Creeks	N
Elwood	601	Elk-Turkey, Etc Creeks	N
Franklin	1,193	Center, Etc. Tribs	N
Guide Rock	318	Minnie Creek	1,300
Haigler	237	Arikaree River	N
Hamlet	64	Frenchman River (Wauneta Tribs)	N
Hardy	250	Superior Tribs	N
Hildreth	352	Thompson Creek	N
Holbrook	307	Deer Creek	N
Holdrege	5,635	Sacramento Tribs	N
Inavale		Farmers, Indian, Etc. Creeks	N
Indianola	672	Coon Creek	N
Lebanon, Danbury, Marion	255	Beaver Creek (Upper)	800
McCook	8,285	McCook Tribs	2,200
Madrid	234	Stinking Water Creek (Upper)	N
Maywood	309	Medicine Creek (Upper)	N
Naponee	187	Turkey Creek	800
Orleans	592	Orleans Tribs	N
Oxford	1,116	Elk-Turkey, Tribs	N
Palisade	372	Frenchman River (Lower)	N
Red Cloud	1,531	Red Cloud Tribs	1,800
Riverton	220	Thompson Creek	1,400
Stratton	481	Culbertson to Stratton Tribs (N)	1,500
Superior	2,779	Superior Tribs	8,200
Trenton	770	Culbertson to Stratton Tribs (S)	N
Venango	218	Venango Tribs	N
Wauneta	738	Frenchman River (Wauneta Tribs)	21,800
Wilcox	280	Thompson Creek	N
Wilsonville	266	Beaver Creek (Lower)	N
TOTAL	35,211		46,200

Note: Price base: Current prices 1975.
N=Nominal - Large infrequent storms could cause significant damages that were not evaluated for this report.

year precipitation for crops in the basin are shown in Table V-11 for the major crops grown. The Palmer Drought Index (Figure III-3) is an indicator of moisture surplus or deficiencies and is calculated as a function of monthly moisture supply, moisture demand, their climatic averages for the area, and the rate of accumulation of the month's deficiencies. The difficulty is that drought is a relative rather than absolute condition. A prescribed set of weather events could provide wet weather in a semiarid region, while an identical set would be regarded as dry or droughty in a humid region. The index provides a measure of the character of the weather spells themselves, but it does not directly measure the many and diversified effects of the weather.

TABLE V-11 NORMAL YEAR CROP CONSUMPTIVE IRRIGATION REQUIREMENT
Republican River Basin, Nebraska

Crop	May	Jun	Jul	Aug	Sep	Oct	Total
	(Acre-Feet/Acre)						
Wheat	.17	.45	.18	.00	.00	.00	.80
Corn Grain	.00	.13	.43	.45	.24	.05	1.30
Corn Silage	.00	.12	.40	.42	.22	.04	1.20
Sorghum Grain	.00	.09	.45	.38	.17	.01	1.10
Sorghum Silage	.00	.09	.45	.38	.17	.01	1.10
Oats	.17	.45	.18	.00	.00	.00	.80
Barley	.17	.45	.18	.00	.00	.00	.80
Veg (All Types)	.00	.09	.45	.38	.08	.00	1.00
Hay (Alfalfa)	.20	.36	.54	.46	.24	.00	1.80
Hay (Clvr-Grass)	.14	.27	.42	.37	.20	.00	1.40
Hay (Other)	.14	.27	.42	.37	.20	.00	1.40
Soybeans	.00	.00	.18	.35	.17	.00	.70
Sugar Beets	.05	.25	.54	.56	.32	.08	1.80
Irish Potatoes	.00	.00	.32	.58	.36	.04	1.30
Dry Beans	.00	.09	.47	.41	.03	.00	1.00
Crop Pasture	.14	.27	.42	.37	.20	.00	1.40
Other Pasture	.14	.27	.42	.37	.20	.00	1.40
Other Crops	.14	.27	.42	.37	.20	.00	1.40

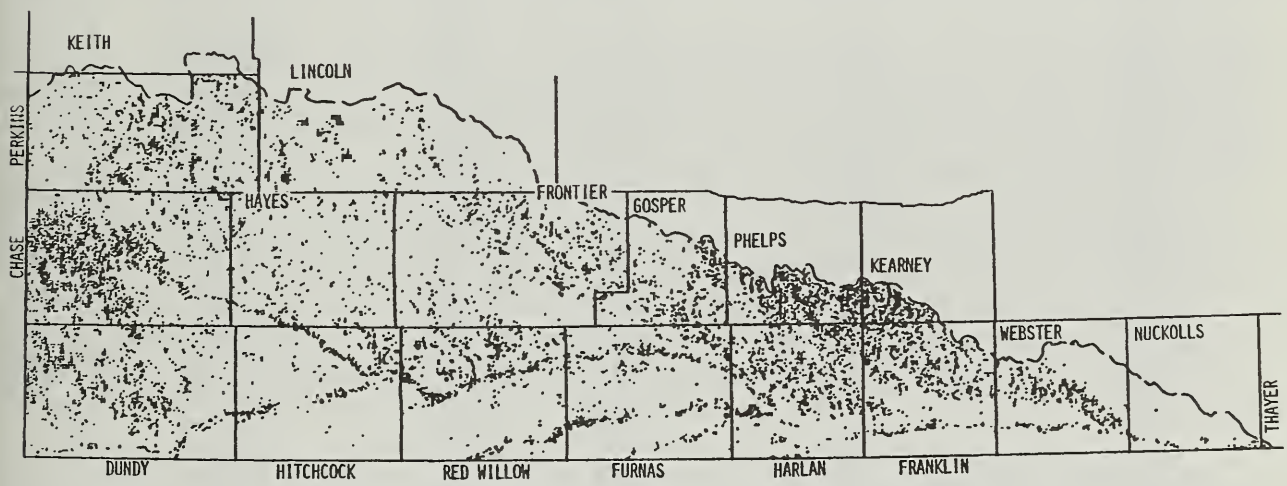
Source: National Water Assessment, 1975.

However, the variability of the weather and extended drought periods that have occurred are readily apparent.

Effect of Irrigation Development on Water Supplies

Competition for water, both surface and ground, is becoming intense and has created shortages in places. The development of sprinkler irrigation systems (primarily center pivot), which permits irrigation of much cropland without land leveling, has resulted in a great expansion of irrigation in most of the basin. In parts of the basin, the ground water resources are being depleted. This often has the effect of depleting streamflow as has occurred in the Frenchman River which Supplies Enders Reservoir. In addition, the water table is lowered. This added lift increases pumping costs, and in some cases, has reduced the rate per minute that water can be pumped. Other increased costs result from having to lower pumps. The density of irrigation wells in the basin is shown in Figure V-2.

FIGURE V-2
REGISTERED IRRIGATION WELLS, DECEMBER 1977



Source: Nebraska Department of Water Resources
Nebraska Conservation Survey Division

Table V-12 indicates the number of registered irrigation wells developed by year in the basin. Although the total number of irrigation wells in a county provides some indication of the amount of irrigation development that has taken place, the number of irrigation wells per square mile of land area in that county is also an index of the degree of development. A high density of irrigation wells generally indicates both that a large percentage of the land is irrigable, and that large amounts of water are available. Very low densities generally characterize counties where development is limited by either small amounts of irrigable land or by aquifers that yield only small amounts of water to wells or both. According to data developed by the Remote Sensing Center, Conservation and Survey Division, University of Nebraska,

TABLE V-12 REGISTERED WELLS AND ESTIMATED ACRES IRRIGATED
Republican River Basin, Nebraska

Year	Municipal and Industrial Cumulative	Irrigation (Number) By Year	Irrigation (Number) Cumulative	Area Irrigated (Acres) By Year	Area Irrigated (Acres) Cumulative
Prior to 1945	27	192	192	18,305	18,305
1945	28	19	211	1,529	19,834
1946	30	31	242	2,413	22,247
1947	32	18	260	1,645	23,892
1948	38	25	285	2,735	26,627
1949	39	21	306	2,324	28,951
1950	42	34	340	3,200	32,151
1951	42	30	370	4,443	36,594
1952	42	45	415	4,856	41,450
1953	45	103	518	15,143	56,593
1954	49	222	740	28,863	85,456
1955	52	274	1,014	34,663	120,119
1956	54	297	1,311	37,280	157,399
1957	56	229	1,540	27,774	185,173
1958	57	39	1,579	4,250	189,423
1959	58	58	1,637	6,887	196,310
1960	58	39	1,676	4,670	200,980
1961	58	61	1,737	7,451	208,431
1962	59	42	1,779	5,505	213,936
1963	60	95	1,874	9,721	223,657
1964	64	140	2,014	15,700	239,357
1965	67	184	2,198	25,784	265,141
1966	77	212	2,410	30,498	295,639
1967	81	254	2,664	36,988	332,627
1968	87	359	3,023	51,619	384,246
1969	89	331	3,354	49,627	433,873
1970	96	297	3,651	43,471	477,344
1971	97	376	4,027	51,859	529,203
1972	101	413	4,440	51,581	580,784
1973	109	455	4,895	64,082	644,866
1974	111	559	5,454	79,191	724,057
1975	116	813	6,267	112,290	836,347
1976	121	819	7,086	113,570	949,917
1977	129	464	7,550	65,062	1,014,979

Source: Nebraska Department of Water Resources.
Note: Acreage based on irrigator's estimate at time of registration of potential service area.

there was a total of 1,695 pivot irrigation systems servicing 237,300 acres in the basin by 1975. This had increased to 2,851 systems servicing 399,140 acres by 1977. About one-half of these systems are located in the three western counties. There were 840 pivot systems located in Chase County, 542 in Perkins County and 491 in Dundy County. Irrigators in Lincoln County, which adjoins Chase County on the east, had developed 234 pivot systems.

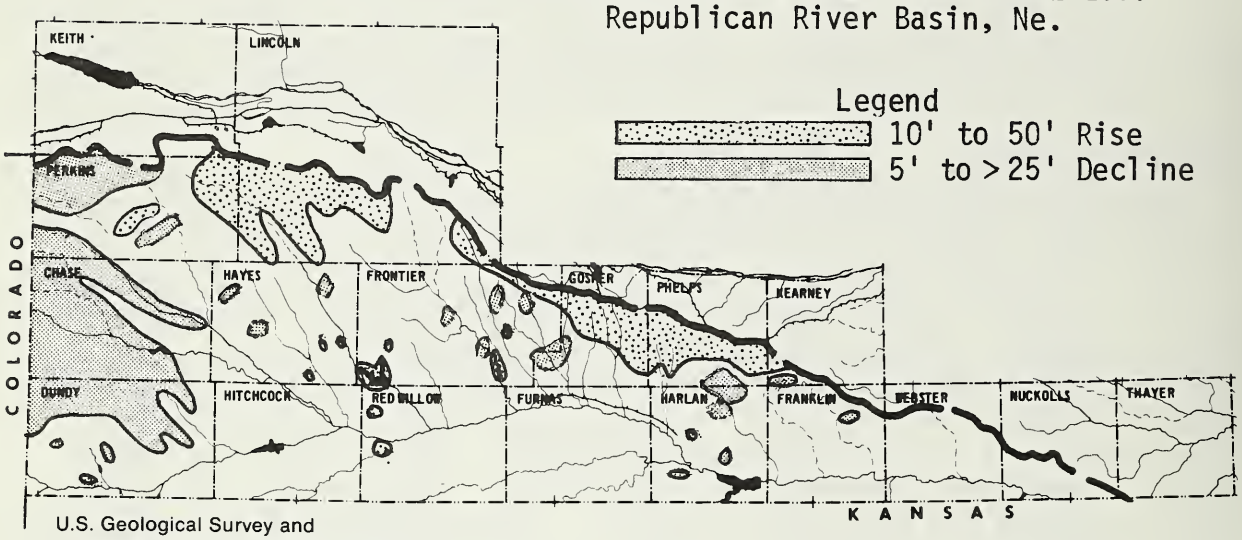
All the Irrigation Districts in the basin experience inadequate project water supply in varying degrees due to the variability of the climate. Swanson, Hugh Butler, Harry Strunk, and Harlan County Irrigation Reservoir water supplies depend significantly on surface runoff to fill the reservoirs. Surface runoff constitutes about two-thirds of the inflow into the reservoirs. However, Enders Reservoir water supply is almost entirely from base flow, and overland runoff is of such short duration that it can be considered negligible. The inflow into Enders Reservoir in recent years has been declining. Consequently, the water supply for farm use has been curtailed. This has resulted in inefficient farm operations as acreages irrigated must be reduced, or crop irrigation needs will be only partially met.

The streamflow depletion of the Frenchman River is attributed to the rapid increases in the use of ground water for irrigation, application of conservation practices and climate variations causing the water levels in wells to decline. Estimated depletion of streamflows at the Imperial gaging station on Frenchman River above Enders Reservoir is about 19 percent. Stinking Water and Spring Creeks above the gaging station at Palisade have been depleted about 18 percent since 1967, according to estimates contained in U.S. Geological Survey Open File Report 76-498. The present amount of stream depletion and the prospect of continuing depletion of streamflow is of growing concern for irrigation of the Frenchman Unit of the Frenchman-Cambridge Division.

Some concerns over depletion of base flow above Swanson Lake have been expressed by the Bureau of Reclamation. If recent trends in streamflows above Swanson Lake continue, it does indicate the possibility of problems ahead for surface irrigators below the reservoir. However, a very limited area in Nebraska affects this flow. The flow in Rock Creek, a part of this area, is also of principal concern. However, to date (1975), streamflow depletion has been seasonal.

Areas in the basin of significant water-level rise or decline from predevelopment water level are shown in Figure V-3. The Imperial Area shows declines in excess of 20 feet in the area that effects Rock Creek and the Frenchman River. The reasons for the ground water rise in south-central Perkins County is not thoroughly understood, but it is believed to be related to a change in farming practices. Improved range management and conservation tillage systems, including stubble mulching in wheat and fallow crop rotations, have increased infiltration rates and reduced evaporation losses and consumptive use by crops.

FIGURE V-3
SIGNIFICANT RISES AND DECLINES IN
GROUND WATER LEVELS AS OF FALL 1977
Republican River Basin, Ne.



U.S. Geological Survey and
Conservation and Survey Div., IANR,
The University of Nebraska-Lincoln

The rise in northeast Perkins, Lincoln, Gosper, Phelps, and Frontier Counties is attributed to ground water recharge by Tri-County system.

These developments and concerns for irrigation water supplies to the major reservoirs in the Republican Basin in Nebraska, Kansas and Colorado will be studied in a Total Water Management Study by the Bureau of Reclamation, Department of the Interior. A Notice of Intent to Study was issued in February, 1977, and a Plan of Study is under development at this time. Actual study activities will be initiated in Fiscal Year 1979.

Agriculture Water Management

Much of the basin has developed and grown under an irrigated agriculture environment. Irrigation has made it possible to make more intensive use of the land, increase the output in many sectors of the economy and raise the standard of living.

Irrigation practices and methods vary from area to area because of available water supplies and economic feasibility. The amount of precipitation available and length of the freeze-free season determine what crops can be grown. Also soil type, topography, quantity, and quality of both surface and ground water available, competitive uses for available water, including in-stream flow and wildlife habitat, size of field and the economic feasibility of alternative irrigation techniques. With irrigation has come some negative impacts such as reduced streamflows, declining ground water tables and reduced water quality.

Careful Application
of Irrigation Water

and Reuse Pits
Conserves Ground Water

A portion of this negative impact can be attributed to irrigation efficiency. On-farm irrigation efficiency can be defined as the volume of water stored in the soil root zone for use by the crop, divided by the volume of water delivered to the farm. On-farm efficiency characterizes both the on-farm distribution system and the field application systems. Water delivered but not stored may include seepage, non-beneficial evaporation, phreatophyte consumption, deep percolation from irrigation field, and intentional spills by the farmer for purpose of regulation. Irrecoverable losses to evaporation, phreatophyte consumption and nonrecoverable ground water were estimated to be about 12 percent of the total diversion or application.

The current estimate of on-farm irrigation efficiency is 55 percent for gravity systems and 65 percent for center pivot systems. However, these irrigation efficiencies do not mean that this percent of water currently being diverted for irrigation can be saved and made available

for other uses. Most of the water seeping from or running off the surface of any given irrigation system returns to streamflows or ground water reservoir where it is available for re-diversion for irrigation or other use.

Approximately 90 percent of the irrigation water is supplied by ground water sources. Due to the high energy requirements of this type of irrigation, low efficiencies mean more total energy consumed and less net profit because of higher operating cost.

Vector Problems

Another negative impact resulting from the irrigation development in the basin is an increased mosquito problem. The Nebraska Department of Health attributes the mosquito problem to several sources: (a) poor irrigation practices, (b) poorly maintained irrigation drainage systems, (c) seepage from the basin's major reservoirs, and (d) fluctuating water levels in these reservoirs. The vector problem will be addressed in the Bureau of Reclamation's forthcoming "Total Water Management Study" for the Republican River Basin.

Effect of Conservation Measures on Runoff

Surface water is an important part of the basins resources in supplying water for surface irrigators. In recent years, concern has been mounting over streamflow depletions, both base flow and surface flow. Studies show that the installation of conservation practices and wise use of soil resources affects the amount, quality and timing of surface runoff.

Conservation Treatment Prevents Erosion and Slows Down Runoff

Procedures for estimating land use and watershed treatment effects of surface flows were developed for the basin using the procedures in Technical Bulletin No. 1352 by the U.S. Department of Agriculture and U.S. Department of the Interior called "Development of a Procedure for Estimating the Effects of Land and Watershed Treatment on Streamflows". Estimates of surface flow depletions from the accumulated effects of land use and treatment through 1975 for the Republican Basin are based on average year conditions and for small upstream watersheds are shown in Table V-13.

The depletion estimates are based on total county area and would not reflect particular soils and topographic conditions or downstream transmission losses that might occur if these figures are to be applied to a particular stream location in the basin. The depletion estimates give a reasonable estimate of an average year surface flow depletion that could occur by county.

Livestock Water

Ground water is the most important source of livestock water in the Republican Basin and is capable of supplying nearly all of water needed. However, for the purposes of convenience, distribution of grazing and reduction of the cost of supplies, much water is supplied for livestock water by farm ponds. However, these ponds may reduce downstream streamflow yields and contribute to reduced flows into reservoirs.

Properly Placed Ponds Provide Livestock Water
and Help Distribute Grazing

TABLE V-13 DEPLETION EFFECTS OF LAND TREATMENT AND FARM PONDS ON SURFACE RUNOFF
Republican River Basin, Nebraska

County	Land Treatment Practices												1975 Runoff: Adjusted for Land Treatment and Farm Ponds	Depletion Through 1975 3/
	Contour Only	Terraced: Contour Minimum Tillage	Minimum Tillage Only	Flat Channel Terraces	Terrace: Level Contour	Irrigation 1/	Terrace Gradient: Contour	Terrace Gradient: Contour Minimum Tillage	Subtotal A	Farm Pond B	Total Depletion A+B	Observed Runoff 2/		
	(Percent)												(Inches)	(Ac. Ft.)
Chase	1.4	0.1	0.7	0.1	0.3	(1.4)	0	0	1.2	4.3	5.5	0.5	0.47	1,311
Dundy	1.5	0.1	0.9	0.8	0.2	(0.4)	0	0	3.1	4.9	8.0	0.5	0.46	1,965
Franklin	0	0	0.4	0	2.4	(0.6)	0	0	2.2	16.6	18.8	1.50	1.24	7,492
Frontier	0	1.7	0.3	0.4	5.6	(0.4)	0.1	0	7.7	28.3	36.0	0.75	0.48	13,401
Furnas	2.9	1.4	0.4	0	7.9	(0.3)	0.1	0	12.4	23.6	36.0	1.00	0.64	13,863
Gosper	0.7	1.2	0.6	0	3.1	(2.2)	0	0	3.4	22.6	26.0	1.00	0.74	4,580
Harlan	0	1.0	0.4	0.2	6.2	(1.0)	1.0	0	7.8	10.6	18.4	1.25	1.02	7,053
Hayes	4.4	0.8	0.4	1.4	3.8	(0.1)	0	0	10.7	10.7	21.4	0.70	0.55	5,687
Hitchcock	3.1	1.0	1.2	2.8	3.1	(0.2)	0	0	11.0	6.1	17.1	0.70	0.58	4,620
Kearney	0	0	1.1	0	0.1	(2.7)	0	0	(1.5)	2.8	1.3	1.50	1.48	70
Keith	0	0	0.5	0.3	0.9	(0.2)	0	0	1.5	0.5	2.0	0.50	0.49	24
Lincoln	0	0.1	0.1	0.3	1.0	0	0	0	1.5	4.0	5.5	0.70	0.66	1,707
Nuckolls	1.4	0.1	0.2	0	0.4	(0.1)	1.5	0	3.5	6.4	9.9	2.00	1.81	1,995
Perkins	0	0	0.9	0	1.3	(0.2)	0	0	2.0	0	2.0	0.50	0.49	378
Phelps	0	0	0.1	0	1.0	(1.0)	0	0	0.1	7.9	8.0	1.25	1.15	1,243
Red Willow	0.4	2.8	0.5	1.9	7.9	(1.2)	0	0	12.3	6.4	18.7	0.75	0.61	5,345
Webster	1.1	0.4	0.6	0	1.7	(0.6)	0.3	0.1	3.6	12.2	15.8	1.75	1.47	6,505
Thayer	0	0	0	0	0	0	4.8	0	4.8	7.2	12.0	2.25	1.98	14
Total														77,253

Note: Estimates are for an average year condition.

1/ Increase in runoff due to irrigated area.

2/ The observed (upland) runoff values used for the average year condition were estimated from USGS stream gage data and the USDA Central Great Plains Experimental Watershed - Hastings, Nebraska.

3/ Based on county area in basin. These values do not reflect areas of sandy soils, noncontributing areas or account for transmission losses.

The average designed capacity of farm ponds is about five acre feet. The effective capacity of the farm ponds is less than the designed capacity due to displacement of water storage capacity by sediment and results in a life expectancy of about 20 years for the reservoirs. This necessitates frequent replacement of these structures. In addition to providing water for livestock consumption, an even greater amount is lost by evaporation. Therefore, the estimate of water consumed by livestock cannot be too closely linked to design capacity. For this study, it is estimated that ground water supplies 65 percent of livestock water, and surface water provides the remaining 35 percent.

About 10,260 acre feet of water is needed to supply the consumptive requirements of livestock in the basin (Table V-14). Almost 90 percent of this amount is needed to supply beef cattle.

TABLE V-14 DAILY LIVESTOCK WATER REQUIREMENTS
Republican River Basin, Nebraska

Type of Animal	Gallons Per Day
	(Thousands)
Milk Cows	224.0
Beef Cattle	8,001.0
Hogs	908.2
Sheep	43.8
Chickens	8.4
Total	9,185.4
Ac. Ft./Day	28.1
Ac. Ft./Year	10,260.0

The current total water use for livestock purposes is about 40 thousand acre feet as shown in Table V-15. About two-thirds of the consumptive needs of livestock is supplied by ground water, and one-third supplied by surface water sources.

TABLE V-15 ANNUAL LIVESTOCK WATER USE
Republican River Basin, Nebraska

Item	Unit	Amount
Water Consumption		
Ground Water	Ac. Ft.	6,670
Surface Water	Ac. Ft.	3,590
Annual Use	Ac. Ft.	10,260
Evaporation		
Farm Ponds	No.	8,968
Surface Area	Ac.	12,160
Annual Evaporation	Ac. Ft.	30,000
Total Annual Use	Ac. Ft.	40,260

Municipal, Industrial and Rural Domestic Water Supplies

There are forty-seven incorporated towns ranging in size from a population of 101 to over 8,000. Of these forty-seven, forty-six have municipal water systems that, with proper maintenance, are adequate to serve the people. Although there are some shortcomings in some of these systems, they are all rated satisfactory at this time. Only one (1) incorporated community, with a population of over 300, does not have a central system. This community is served by individual wells. As this community is also served by a central waste disposal system, pollution of ground water supplies is minimal. However, fire protection could be improved by the installation of a central system.

Twenty-three villages with populations under 100 were identified in the study. Approximately one-half of these are incorporated. These villages rely upon individual wells for water supply as these small communities lack the economic base to finance community systems. However, at least eight villages have wells with nitrate levels currently exceeding or nearing the 10.0 parts per million (ppm) nitrate-nitrogen standards allowable under Nebraska law. These villages must monitor their water quality and maintain nitrate concentrations under 10 ppm or eventually locate replacements for the affected wells.

Rural farm and nonfarm homes also rely on individual wells for domestic water. These water supplies are generally adequate and of good quality except for a narrow strip along the Kansas-Nebraska border ranging up to twenty miles in width. This area has either low quality

water or inadequate supplies or both. However, as the area is sparcely inhabited, no interest has been expressed for the need of a rural water system.

Water Use

The current average water use in the basin for selected purposes amounts to about 915 thousand acre feet (Table V-16). Of this amount, about 83 percent is consumptively used by irrigated crops. Surface evaporation from all reservoirs and ponds amounts to 11 percent of the

TABLE V-16 CURRENT WATER USE BY SELECTED PURPOSE
Republican River Basin, Nebraska

	Current
	(Ave. Ann. Acre Feet)
Irrigation 1/	761,800
Livestock 1/	10,300
Farm Ponds and Small Reservoirs 2/	55,900
Large Reservoirs 2/	46,000
Types 3 and 4 Wetlands	5,700
Municipal, Industrial and Rural Domestic 1/	7,500
Land Treatment 3/	27,900
Total	915,100

1/ Consumptive use does not reflect other losses such as evaporation, canal seepage, etc. Amounts based on current irrigated acres used in this report.
2/ Surface evaporation = (.7) (max. surface area) (Net lake evaporation).
3/ While not specifically a use, these figures are shown to signify reduction of surface runoff from upstream small watersheds conservation measures.

total water use. Land treatment practices have resulted in increasing infiltration and reducing runoff by about 28 thousand acre feet or 3 percent of the total water used. Detailed studies were made only on the effect of land treatment measures on runoff. The other data in this table were estimated on a general basis and are intended to only reflect the magnitude of water use in the basin.

Waste Water and Sewage Treatment

Forty of the forty-seven incorporated urban and rural communities in the basin have municipal waste treatment systems. These sewage treatment facilities provide a central waste disposal service to 39,523 residents. The remaining seven incorporated communities and rural households have individual waste disposal treatment facilities. There have been no pollution problems of streams or ground water reported. However, the living conditions in some of these communities might be improved and possible danger of pollution reduced by installation of a central disposal system. A grouping of the existing sewage treatment developments using 1970 population data is shown in Table V-17.

TABLE V-17 MUNICIPAL AND RURAL DOMESTIC SEWAGE TREATMENT DEVELOPMENTS
Republican River Basin, Nebraska

Category	Municipal Waste Treatment Systems		Individual Waste Treatment Systems		Total	
	Places	Pop.	Places	Pop.	Places	Pop.
Over 2500	3	16,699			3	16,699
1000-2500	10	12,634			10	12,634
500-1000	7	5,037			7	5,037
250-500	8	2,702	1	266	9	2,968
Under 250	12	2,451	6	952	18	3,403
Total	40	39,523	7	1,218	47	40,741

Source: Comprehensive Regional Water and Sewer Plans, Farmers Home Administration.

Water Quality

The quality of water in flowing streams is generally satisfactory with most of the parameters, as shown in Table V-18, meeting the water quality standards set by the State of Nebraska. There are periods during floodflows when the standards are exceeded.

Violations have occurred in the 21 stations analyzed; however, the mean or average values for each parameter was within criteria standards. The types of violations observed were conductivity (7), Dissolved Oxygen (6), pH (9), and Nitrogen (5). One station, Medicine Creek at Stockville, has a geometric mean based upon 6 samples, which exceeds

TABLE V-18 WATER QUALITY DATA
Republican River Basin, Nebraska

Str. Seg.	Station	Ortho Phosphorous (mg/l) No.	Avg.	Max.	Min.	Total Nitrogen (mg/l) No.	Avg.	Max.	Min.	Fecal Coliform (Coli/100 ml) No.	Avg.	Max.	Min.	Water Temperature (Centigrade) No.	Avg.	Max.	Min.	Dissolved Oxygen (mg/l) No.	Avg.	Max.	Min.	pH (pH Value) No.	Avg.	Max.	Min.	Conductivity (u mho/cm) No.	Avg.	Max.	Min.	Turbidity (NTU) (nephelos units) No.	Avg.	Max.	Min.
1	Rep.R. at Riverton	7	0.2	0.5	0.1	13	0.8	1.8	0.3	14	292	3400	82	15	11	22	0	15	9.3	12.9	6.6	15	8.2	8.6	7.3	15	572	690	255	14	11.3	29	5
2	Rep.R. at Naponee	4	0.3	0.6	0.1	20	0.9	2.2	0.0	15	137	23000	1	21	11	24	0	21	9.7	13.5	6.2	21	8.0	8.5	7.3	21	535	680	200	21	13.7	1400	4
3	Prairie Dog Cr. at Alma S.	3	0.3	0.4	0.1	17	0.8	1.8	0.0	13	114	5100	1	19	11	25	0	19	7.2	13.0	1.8	19	7.8	8.7	7.3	19	870	2910	220	19	52.1	1630	3
3	Rep.R. at Orleans S.	4	0.2	0.2	0.1	16	0.8	1.6	0.0	14	76	800	1	21	13	25	0	21	9.5	11.5	6.7	21	8.2	8.6	7.6	21	571	900	355	21	52.6	1630	2
6	Rep.R. at Orleans W.	10	0.3	0.6	0.1	17	1.2	4.3	0.0	19	72	2918	1	20	11	24	0	19	10.2	13.1	7.7	19	8.3	8.9	7.8	20	595	900	370	20	41.9	284	6
8	Rep.R. at Cambridge	4	0.3	0.5	0.1	14	2.0	14.0	0.4	4	20	3500	1	18	12	22	0	17	9.3	12.4	5.8	17	8.2	8.6	7.6	17	580	750	320	17	55.0	1560	7
12	Rep.R. at Culbertson	4	0.0	0.1	0.0	9	1.8	6.8	0.2	4	2	20	1	12	12	26	0	12	9.9	12.0	7.7	12	8.3	8.6	7.9	12	714	900	359	12	5.8	24	2
12	Rep.R. at Benkelman	10	0.1	0.2	0.0	142	0.3	4.8	0.0	84	31	70000	1	143	12	33	0	146	9.5	12.9	5.8	145	8.3	8.8	7.6	147	519	1025	130	148	54.7	8500	2
13	S.Fk.Rep.R. at Benkelman	1	0.1	0.1	0.1	12	0.6	3.8	0.0	1	1	1	1	14	15	27	2	14	8.6	13.3	5.9	14	8.2	8.5	7.9	14	469	680	6	14	45.0	5030	2
13	N.Fk.Rep.R. at Sanborn	10	0.1	0.2	0.0	26	0.9	1.8	0.0	12	80	1180	1	30	12	30	0	30	9.0	12.8	6.5	30	8.1	8.6	7.8	30	440	660	9	31	19.3	470	2
13	Arikaree R. at Haigler	3	0.1	0.1	0.0	17	0.5	3.5	0.0	3	30	2300	1	20	11	26	1	20	9.0	13.2	5.4	20	8.1	8.4	7.8	20	704	1510	200	20	31.7	3570	2
4	Sappa Creek at Stamford	2	0.2	0.2	0.2	11	0.6	1.4	0.1	9	612	42000	1	13	12	20	2	13	8.6	12.9	4.8	13	7.9	8.4	7.5	13	485	745	231	13	93.2	960	5
6	Beaver Creek at Marion	--	--	--	--	10	1.3	8.0	0.0	5	1302	32500	100	11	12	19	1	11	7.2	12.0	3.2	11	7.8	8.4	7.0	11	489	900	11	11	64.7	490	10
7A	Medicine Cr. at Wellfleet	4	0.1	0.3	0.0	9	0.5	1.9	0.1	4	6	40	1	12	13	22	3	12	9.7	12.8	7.5	12	8.2	8.6	7.8	12	377	440	293	12	17.4	31	8
7A	Medicine Cr. at Stockville	6	0.2	0.3	0.1	10	1.8	7.3	0.0	6	692	26000	131	14	11	23	1	14	10.4	12.6	6.5	14	8.2	8.4	7.8	14	420	460	337	14	50.8	213	21
7B	Medicine Cr. at Cambridge	4	0.1	0.2	0.0	15	0.2	1.0	0.0	5	24	100	1	19	12	22	1	18	9.9	15.3	7.1	18	8.1	8.3	7.7	18	394	560	274	18	9.8	18	5
9A	Red Willow Cr. at McCook	4	0.3	0.9	0.0	9	0.5	1.5	0.1	4	24	120	3	12	14	22	3	12	10.5	16.6	7.1	12	8.0	8.4	7.8	12	518	620	321	12	13.2	48	2
9B	Red Willow Cr. at Indianola	4	0.3	0.8	0.1	15	0.7	1.9	0.1	4	188	880	20	19	12	21	0	19	9.1	11.9	6.5	19	8.0	8.3	7.8	19	559	750	348	19	51.5	250	10
11A	Frenchman R. at Lamar	-	--	--	--	5	0.6	1.2	0.0	-	--	--	--	7	11	22	2	7	7.9	10.0	4.2	7	7.7	8.1	7.3	7	386	490	260	7	17.7	1050	2
11B	Frenchman R. at Enders SE	3	0.1	0.2	0.0	16	0.3	0.6	0.0	3	1	1	1	20	14	20	6	20	8.3	11.2	5.9	20	7.9	8.5	7.5	20	386	465	263	20	4.4	68	1
11B	Frenchman R. at Culbertson	4	0.1	0.1	0.0	16	2.2	5.8	0.2	4	263	1320	67	21	13	24	3	21	9.0	11.8	6.4	21	8.1	8.4	7.7	21	501	680	365	21	37.9	370	6

Source: Nebraska Department of Environmental Control

the criteria for fecal coli. The delivery and deposition of sediment amounting to 6 million tons annually contributes to the deterioration of the water quality.

Woodland Management

Forest and woodland acreages have sustained substantial losses in the last 15-20 years. Field windbreaks have been removed to allow development of areas for pivot irrigation systems. A significant amount of trees in the bottom lands have also been removed to allow more intensive farming and irrigation. Insects and diseases have caused losses of trees through reduction in growth, lower quality, deformities, rot, and death. Dutch Elm Disease is killing or has killed most of the American Elm. The loss of these trees leaves a temporary void in the tree population. Dead trees clog channels causing increased flooding and damage to bridges and add to the debris left on land by floods. Livestock grazing is a major source of damage to the limited acreage of woodlands when used for grazing, shade and shelter. Browsing soon kills seedlings and young trees and removes the understory vegetation. The heavy trampling and trailing of livestock compacts the soils and humus and seriously impairs the capacity of the woodlands to infiltrate precipitation and reduce runoff and erosion.

It is estimated that, in spite of new plantings, the total area of forest and woodland has been reduced from 56,000 acres in 1955, as reported in the Nebraska State Forester, to about 40,000 acres currently; a loss of 16,000 acres. This loss has diminished the esthetics provided by trees, reduced wildlife habitat, and at times, has removed stabilizing vegetation from streambanks. The removal of windbreaks has also increased the hazard to wind erosion damage in many fields.

Range and Woodland Fires

An average of about 175 range fires occur each year in the basin, burning an average of about 5,000 acres. Wildfires destroy the ground cover of litter and humus and kill young trees and shrubs. Other damages of perhaps greater impact, but not so easily measured, are the indirect effects of damage to the hydrologic condition, the increase in surface runoff which increases soil erosion, the reduction in grass and tree growth, the reduction in timber quality, and the reduction in resistance of trees to disease and insect infestation.

Recreation

The national trend toward increased participation in outdoor recreation activities is apparent in Nebraska. This increase in use has put a strain on recreation facilities across Nebraska. For example, from 1968 to 1975, the number of visitors at Harlan County Reservoir has

increased from 614,400 to 954,700. The residents in the Republican River Basin are fortunate in having five large multiple use reservoirs ranging in size from 1,628 to 13,700 surface acres with a total surface area of 23,777 acres. The major supply of recreation facilities found in the basin is located at these reservoirs.

Even with a large quantity of private, municipal, State, and Federal recreation sites and facilities, a shortage of camping facilities occurs during peak days (Table V-19). This shortage is expected to be alleviated with the completion of new camping facilities currently under construction. Stream and lake fishing abounds within the basin. Several

TABLE V-19 RECREATION VISITS
Republican River Basin, Nebraska

Recreation Activity	Population Participating (Percent)	Annual Participation (No.)	Current Annual Demand (Visits)	Percent of Annual Demand Occurring on Peak Days Per Season (Percent)	(Days)	Peak Capacity of Existing Areas (Visits)	Annual Demand Occurring on Peak Days (Visits)
Swimming							
Beach	30	6.8	292,120	40	12	167,280	116,848
Fishing							
Flat Water	38	10.4	560,320	30	27	571,050	168,100
Flowing Water	20	10.0	283,560	30	27	110,781	85,070
Picnicking	60	5.0	425,340	60	21	278,250	255,200
Camping	38	8.6	463,340	50	31	180,296	231,670
Power Boating	22	8.6	271,910	65	28	266,784	176,740
Water Skiing	10	5.0	74,430	65	28	133,392	48,380
			(Hunter Days)				
Hunting			Curr.Ann.Demand			Available	
Pheasant	16	8.0	178,264	--		130,900	--
Quail	10	6.0	75,892	--		91,463	--
Dove	10	5.6	68,409	--		84,654	--
Cottontail	3	5.4	23,236	--		125,471	--
Deer	4	4.5	23,088	--		27,060	--
Subtotal			368,890			459,548	

Source: Data from Nebraska SCORP, 1973, and Nebraska Game and Parks Commission.
Note: Data unavailable to compute need for waterfowl or squirrel hunting.
Area of influence population is 141,800.

streams have sediment and erosion problems, but with treatment installed, would provide an increased opportunity primarily for catfish and trout fishing. Hunter days available in the basin currently exceeds hunter days of demand in all categories except in pheasant hunting. The ring-neck pheasant is the number one upland game bird in the basin and in the State.

Fish and Wildlife

Problems identified by the basin's Natural Resources District and the Nebraska Game and Parks Commission include: (1) habitat loss or degradation due to land conversion practices and improper land use practices; (2) streambank erosion and stream flooding and sedimentation; and (3) loss of wetlands.

Comparisons of hunting demand with hunting days available show a surplus of 90,658 hunting days (Table V-19). However, this arises from the limited use of cottontail rabbits by hunters. Pheasants, however, are hunted in excess of supply, and quail and deer hunting is approaching the available supply. Much of the decline in pheasant, squirrel, cottontail, and deer harvests is due primarily to losses of habitat or habitat quality.

Improper land use has resulted in losses of wildlife habitat as 218,000 acres of Class VI and VII lands are used as cropland. In addition, there are 184,000 acres of Class VII rangelands that have excessive soil loss rates which cause mud flats, increase turbidity of water and cover spawning areas with sediment.

Wetlands in the east central portion of the basin are on soils and slopes which are conducive to agriculture, and extensive drainage has taken place. The number of wetlands has been reduced by 82 percent, and acreage reduced by 65 percent based on figures developed in the late 1960s. Acres and numbers of wetland basins have declined since. In recent years, increased irrigation has also caused a decrease in the amount of wildlife habitat as areas of these lands were converted to other uses, primarily cropland. Included in this conversion are many acres of riparian woodland along the Republican River.

Virtually, all of the wildlife is produced on private lands with limited availability to many hunters. Although most of the landowners allow hunting by permission or invitation, access to the hunting opportunities on some private land continues to be difficult due to inability to locate the landowner. However, the opportunities are available provided the hunter makes prior arrangements.

Lake and pond fishing resources as well as stream fishery resources are not fully utilized by fishermen. The difference between total peak capacity of the resource, 681,831 fisherman days and the present peak use of 253,170 fisherman days, show an idle capacity of 428,661 fisherman days. Part of the idle capacity is the result of inadequate access to the existing stream resources. The quality of reservoir fishing has declined in recent years principally because of high rough-fish populations, although high turbidity and untimely reservoir drawdowns also limit game fish production. These factors also contribute to the idle capacity of the resource.

Another stream fishing problem is associated with water quality. Pollution of streams by sediment has lowered the fish carrying capacity of several streams throughout the basin. Sediment has limited channel catfish spawning on Medicine, Red Willow, Stinking Water, and Spring Creeks and has affected trout populations on Thompson and Elm Creeks. Sediment buildup is probably the principal limiting factor to fish populations in farm ponds.

Impairment of Natural Beauty

The natural beauty of the Republican Basin pastoral scene is often impaired by the forces of man and nature. Excessive sheet and gully erosion scars the landscape, produces sedimentation of streams, rivers and reservoirs and increases the turbidity of these water resources. Periods of drought diminish or destroy most of the beauty of the vegetative cover.

The landscape is littered with hard waste such as old car bodies, worn out machinery, tin cans and bottles. Some unsightly dump grounds are near rural communities or along well traveled roads. Car bodies have been used as "riprap" in an effort to control streambank erosion.

Flooding occasionally deposits brush and trash on valuable lands or on installations in the flood plain. However, nature soon heals many of these scars with vegetation. Except for the "riprap" and dumps, man contributes to the healing process by removing or spreading unsightly deposits and "restoring" the landscape to its natural condition.

CHAPTER VI
PROJECTED FUTURE CONDITIONS

Future without plan conditions is described in order to assist in identification of needs, formulation of alternative plans and comparison of alternatives. The future without condition is defined as "the level of development of water and land resources without new Federally assisted projects, without group type projects and without acceleration of on-going programs". Estimates of future without plan conditions will provide a basis for evaluation of Federally assisted programs. Component needs are the differences between without condition and the desired future condition. Both economic and environmental objectives are considered.

Assumptions

The future of agriculture in the area without a plan must be projected to provide a basis for measuring plan impacts. A "without plan" projection recognizes that changes do and will occur. Projections of land use, resource developments and crop yields are based upon assumptions. A combination of these items provides projections of crop production under future without conditions. These assumptions include:

1. Historic trends provide some insight to provide direction for the future.

2. Technological improvements will continue to be available and utilized by producers.

3. It is assumed that for most of the basin there is sufficient water to support increased irrigation development. However, in some localized areas, this will not be true.

4. Land resources are known and limited in quantity.

5. Labor availability will be adequate.

6. Capital will not be a limiting factor.

7. The great majority of the land in the basin will continue to be owned and managed by farmers and used primarily for agriculture.

8. Wildlife will continue to use agricultural land, crops and crop residue. Exclusive wildlife habitat will continue to be odd areas, prime wildlife wetlands and similar areas. Miscellaneous lands such as fence rows and road borrow ditches will have improved management for wildlife habitat.

9. The growth of population in adjacent basins and metropolitan areas outside the basin will further increase the demand for recreation of all types.

Projected Programs and Projects

Certain programs related to agriculture are assumed to continue as part of the future conditions without a plan. Included are soil and water conservation and erosion control programs of the Natural Resources Districts with technical assistance provided by the U.S. Soil Conservation Service and U.S. Forest Service, and agricultural and forestry research carried out by the U.S. Department of Agriculture, colleges, universities, and private enterprise.

Continuing programs designed to reduce nonagricultural floodwater damage such as the flood insurance program administered by the U.S. Department of Housing and Urban Development and land use planning by all levels of government are assumed to continue.

State laws and Federal laws such as the Clean Water Act (Public Law 92-217) and the National Environmental Policy Act will continue to provide regulations that protect water quality. The supply and distribution of public water will continue to be served by these programs: (1) county water planning, (2) ground water studies by the U.S. Geological Survey and the Conservation of Survey Division, University of Nebraska, (3) community loans from the Farmers Home Administration, and (4) grants by the U.S. Department of Housing and Urban Development.

Continuing programs related to forestry are: (1) the fire control system, tree distribution, vegetation management, tree improvement, and the pest control administered by the Nebraska Department of Forestry, Fisheries and Wildlife, (2) technical assistance by that department and the U.S. Forest Service and (3) all government and private research programs.

Recreational programs assumed to continue are: (1) the State park system administered by the Nebraska Game and Parks Commission, (2) grants for recreational development from the Heritage Conservation and Recreation Service and the Farmers Home Administration, (3) technical assistance from the Soil Conservation Service, and (4) private development.

Six PL-566 watershed projects, Dry Creek (Pilot), Dry Creek South, Stamford, Medicine Creek Upper, Medicine Creek Lower, and Blackwood Creek, are assumed to be installed and to be maintained throughout their useful lives as planned.

The irrigation projects supplied by surface water, either by direct diversion from streamflow or from reservoir storage of base and floodflows, are assumed to continue to operate at current levels. Even though

base flows are diminishing and threaten water supplies, it is assumed that alternative ways will be developed to continue supplying irrigation water at about the same rate as is supplied currently. An intensive five-year study, "Total Water Management, Republican River Basin", in Colorado, Kansas and Nebraska has been initiated by the Bureau of Reclamation, Department of the Interior. The study results are expected to provide the data for modifications of these assumptions, if needed.

Two local projects, Wauneta and the Kelly Creek projects, are assumed to be installed and maintained as planned by the Upper and Middle Natural Resources Districts, respectively, and the Nebraska Natural Resources Commission. In a similar manner, the local protection projects installed by the Corps of Engineers are assumed to be maintained throughout their intended life span as planned.

Projected Land Use

Major land uses are projected to remain unchanged except for the shift of nonirrigated cropland to irrigated cropland (Table VI-1). Forested land is expected to decrease slightly. At this time, however,

TABLE VI-1 PROJECTED LAND USE
Republican River Basin, Nebraska

Land Use	Current	Year 2000	Year 2020
	(Thousands of Acres)		
Cropland	3,060.1	3,060.1	3,060.1
Nonirrigated	2,482.0	2,172.5	2,092.5
Irrigated	578.1	887.6	967.6
Pasture and Range	2,822.0	2,822.0	2,822.0
Forest	40.0	39.0	39.0
Other Agriculture	97.8	98.8	98.8
Total	6,019.9	6,019.9	6,019.9

there appears to be no reason to expect any significant conversion of agricultural land to nonagricultural uses. It is expected that some Class VI and VII cropland will be converted to grazing or wildlife uses and established to permanent cover. Similarly, some Class I through Class IV range and pasture lands will be converted to cropland. For the purpose of this study, these conversions to and from cropland and range are assumed to be in equal increments.

Nonirrigated Cropland

It was assumed that total cropland acreage, including fallowed land, will not significantly change in future years. Projected nonirrigated cropland, therefore, became the remainder after the projected irrigated cropland was removed from the total. Other projections were considered for nonirrigated cropland, but they did not appear to be as reasonable as the projections based on the above assumption.

Irrigated Cropland

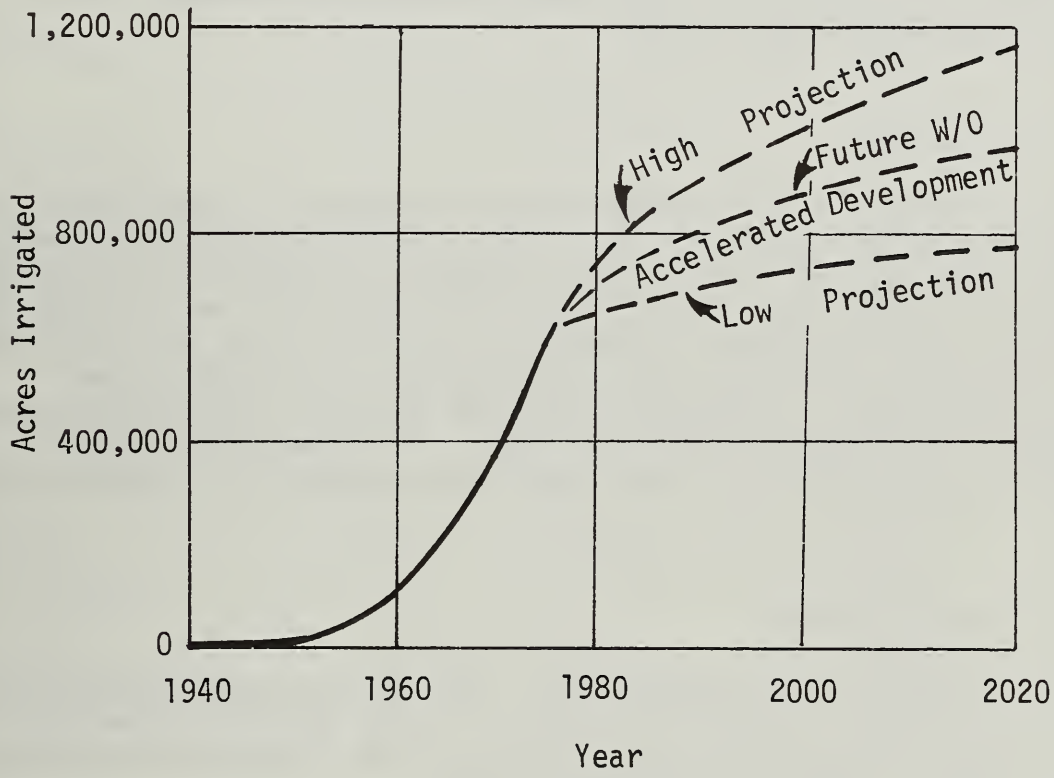
The "without plan" projection of irrigated crop acres was made after examining several alternative sets of projections. The projection

Pivot Irrigation is Expected to Increase

selected shows irrigation to continue to increase but at a decreasing rate. This projection, which is curvilinear in form, is based on the past 35 years of historical data. It projects that irrigation will

increase at an average annual rate of about 3.2 percent between 1975 and 1985, 1.1 percent between 1985 and 2000 and only 0.45 percent between 2000 and 2020. Between 1970 and 1975, irrigated cropland grew at an annual rate of over 12 percent. The base for irrigated cropland is 578,100 acres and is projected to increase to 887,600 acres by 2000 and 967,600 acres by 2020, Figure VI-1.

FIGURE VI-1
PROJECTED IRRIGATED ACRES
Republican River Basin
Nebraska



One alternative projection shows the following amounts of irrigated cropland: 670,500 acres in 1985, 732,800 acres in 2000 and 772,800 acres in 2020. A second alternative projection shows 855,500 irrigated cropland acres in 1985, 1,042,400 acres in 2000 and 1,162,400 acres in 2020. It appears that eco-fallow systems offers a means of conserving moisture and energy use on nonirrigated cropland. As eco-fallow systems improve, the potential gain from shifting to irrigation may diminish.

Surface water resources have already been extensively developed in the basin. Consequently, the vast majority of the projected increase in acres irrigated is expected to be achieved by ground water development. Some increases in acres irrigated by surface water could be achieved by increased efficiencies in the present systems. It is anticipated that almost all the increase irrigated acreage will be on the Class B and C lands as defined in Chapter V. There will be some Class D land developed

as a result of being isolated within center-pivot areas of otherwise desirable irrigable soils. However, it is expected that the relationship of the class of lands developed for irrigation will be similar to those irrigated currently (Table V-8). It is projected that about 77 percent of the land irrigated will be Class A and B lands, 19 percent will be Class C, and about 4 percent will fall in Class D.

Pasture and Rangeland

Pasture and range acres were held constant throughout the various projections and projection periods. Historically, there have been some variations in the amount of land used as pasture and range, but the change has not been significant.

Forest and Woodland

The acreage of forest and woodland is expected to decrease to 39,000 acres by year 2000 and will remain relatively stable thereafter. Although there will be miscellaneous commercial production for pallets, box timber and the like, the principal use will be for wildlife habitat, contribute to good hydrologic conditions, provide shade for the occupants of the basin and livestock, and stabilization of streambanks and miscellaneous areas. Forests and woodland are also esthetically valuable and support a variety of flora and fauna. It is anticipated that approximately 80 percent of the forest and woodland will continue to be grazed.

Other Agricultural Land

The acreage of other agricultural land is also expected to remain relatively stable. A slight increase to 98,800 acres is expected to occur as roads are improved and additional land is devoted exclusively to recreation or fish and wildlife habitat.

Crop Yields

Yields by crop were chosen from two sets of projections. The first set was from yield projections that were made for every county in Nebraska during the recent Platte Level B Study. Those yield projections included projections for each of several soil resource groupings (SRG). Preliminary yield projections were based on rates of increases projected by OBERS and projections made for the Missouri Comprehensive Framework Study. A multidisciplinary group made up of a soil scientist from SCS, a representative of the U.S. Bureau of Reclamation, two agronomists, one agricultural economist from the University of Nebraska, and an agricultural economist from ESCS then examined those preliminary yield projections and adjusted them where necessary.

The second set of yield projections used in this study were based on historical yields for the 12 counties that make up most of the basin. The two sets of yield projections were examined for reasonableness and consistency. The yields selected are shown in Table VI-2 and are

TABLE VI-2 CURRENT AND PROJECTED CROP YIELDS PER ACRE, FUTURE WITHOUT PLAN
Republican River Basin, Nebraska

Crop/Condition	Unit	Base	2000	2020
Wheat				
Irrigated	Bu.	43.8	58.0	63.0
Nonirrigated	Bu.	35.2	44.9	50.9
Rye				
Nonirrigated	Bu.	21.4	31.6	36.3
Corn for Grain				
Irrigated	Bu.	108.4	161.5	187.0
Nonirrigated	Bu.	42.1	50.6	53.2
Grain Sorghum				
Irrigated	Bu.	67.9	131.1	144.7
Nonirrigated	Bu.	40.4	62.0	66.5
Oats				
Nonirrigated	Bu.	40.6	60.0	68.9
Barley				
Nonirrigated	Bu.	33.4	49.4	56.7
Silage				
Irrigated	Ton	16.1	30.6	35.9
Nonirrigated	Ton	7.8	11.7	12.5
Alfalfa Hay				
Irrigated	Ton	4.3	5.2	5.5
Nonirrigated	Ton	2.4	2.9	3.0
Other Hay				
Nonirrigated	Ton	1.9	2.3	2.4
Soybeans				
Irrigated	Bu.	31.5	46.3	50.6
Nonirrigated	Bu.	24.0	25.5	25.6
Sugar Beets				
Irrigated	Ton	17.1	20.8	22.5
Dry Beans				
Irrigated	Cwt.	16.2	19.4	20.8
Cropland Pasture				
Irrigated	AUM	12.0	14.0	15.0
Nonirrigated	AUM	3.0	3.6	4.0
Permanent Pasture				
Irrigated	AUM	12.0	14.0	15.0
Nonirrigated	AUM	1.5	2.5	3.0
Range				
Nonirrigated	AUM	.37	.60	.69

generally increasing but at slower rates over time. These slower rates recognize that genetic gains will be smaller and higher prices of fertilizer will affect gains in productivity.

Projected Cropping Patterns and Prices

Table VI-1 also shows the general land use pattern for the current and future nonirrigated croplands for the projection period "without plan". The cropping pattern that existed in the base year was used for the future years as well. There are several reasons for maintaining the cropping pattern. According to planning guidelines, the same prices or "normalized" prices (Table VI-3) are to be assumed for the future.

TABLE VI-3 CURRENT NORMALIZED PRICES FOR PRINCIPAL COMMODITIES
Republican River Basin, Nebraska

Commodity	Unit	Price Per Unit
Wheat	Bu.	3.31
Rye	Bu.	2.06
Corn for grain	Bu.	2.46
Oats	Bu.	1.42
Barley	Bu.	2.05
Sorghum grain	Cwt. (bu.)	3.99 (2.23)
All hay, baled	Ton	41.28
Dry beans	Cwt.	17.58
Sugar beets	Ton	34.79
Soybeans	Bu.	5.04
Potatoes	Cwt.	3.68
Silage	Ton	13.23
Cattle	Cwt.	39.22
Calves	Cwt.	35.96
Sheep	Cwt.	8.87
Lambs	Cwt.	37.94
Hogs	Cwt.	38.95
Milk	Cwt.	7.13
Commercial broilers	Lbs.	.248
Turkeys	Lbs.	.332
Eggs	Doz.	.357
Grazing	AUM	12.00

Source: Agricultural Price Standards, U.S. Water Resources Council, October, 1976. Silage and grazing values by USDA River Basin Staff.

Therefore, if relative prices do not change, it is reasonable to expect no basic changes in crops grown. In addition, the main shift in cropping patterns that has been happening historically is the decline in non-irrigated corn production. That trend appears to have leveled out in recent years.

Livestock Production

The "without plan" projections for livestock products are shown in Table VI-4. These projections were based on allocating State level projections to the Republican River study area. Production data are

TABLE VI-4 PROJECTIONS FOR LIVESTOCK PRODUCTS
Republican River Basin, Nebraska

Item	Unit	Base	2000	2020
		(Thousands)		
Beef & Veal	Lbs.	261,380.0	338,161.0	359,578.0
Pork	Lbs.	78,362.0	111,593.0	122,753.0
Lamb & Mutton	Lbs.	1,134.0	564.0	294.0
Milk	Lbs.	69,700.0	42,501.0	31,597.0
Chickens	Lbs.	330.5	24.0	5.9
Eggs	Doz.	2,667.0	513.0	233.0
Value of Output	Dol.	139,469.1	179,525.6	191,287.8

reported at the State level only for most livestock products. A curvilinear function was fit to the historical statewide data. Once State level projections were made, the production was allocated to the study area. The method for that allocation was the same as that used in Chapter IV to disaggregate OBERS State level projections.

Livestock production and value of output will increase from $139.4 million currently, as a result of increased feeding efficiencies as well as increased numbers, to $179.5 million by the year 2000. Pork, beef and veal are the only categories projected to increase.

Projected Production and Value

The projected crop production and gross values are expected to increase substantially from current levels by year 2000. As an example, the production of corn harvested for grain more than doubles, increasing

from 51.5 million bushels with a value of $126.7 million to 112.2 million bushels with a value of $275.4 million. This increase in corn production and value reflects the influence of increased irrigation acreages as well as an expected increase in yields. Other crops, with the exception of nonirrigated soybeans, will also increase in total production and value primarily as a result of yield increases. All crops will increase in value from $310.6 million for the base year to $522.6 million by the year 2000 (Table VI-5). These are gross values of output and do not reflect production or resource development costs. The same prices were used for the base year as well as all projections.

TABLE VI-5 PROJECTED ACRES, PRODUCTION AND VALUE OF PRODUCTION, FUTURE WITHOUT PLAN
Republican River Basin, Nebraska

Land Use	Production Unit	2000 Acres	2000 Production	2000 Value($)1/	2020 Acres	2020 Production	2020 Value($)1/
		(Thousands)			(Thousands)		
Cropland		3,060.1		498,947.8	3,060.1		591,669.8
Nonirrigated		2,172.5		176,017.3	2,092.5		187,327.8
Wheat	Bu.	681.8	30,611.5	101,324.0	656.7	33,424.0	110,633.4
Rye	Bu.	7.1	223.4	460.2	6.8	247.2	509.2
Silage	Ton	23.5	275.1	3,639.1	22.6	283.1	3,745.7
Corn for Grain	Bu.	94.9	4,803.0	11,815.3	91.4	4,863.5	11,964.3
Grain Sorghum	Bu.	252.3	15,642.0	34,881.6	243.0	16,159.5	36,035.7
Oats	Bu.	8.1	484.2	687.6	7.8	535.4	760.2
Barley	Bu.	1.5	71.6	146.8	1.4	78.8	161.6
Alfalfa Hay	Ton	67.8	196.5	8,254.4	65.3	195.8	8,225.3
Other Hay	Ton	86.9	200.0	8,198.4	83.7	201.0	8,240.0
Soybeans	Bu.	1.7	42.8	215.9	1.6	41.5	209.0
Fallow		628.1	--	--	605.0	--	--
Cropland Pasture	AUM	148.0	532.8	6,394.0	142.6	570.3	6,843.4
Idle		170.8	--	--	164.6	--	--
Irrigated		887.6		322,930.5	967.6		404,342.0
Wheat	Bu.	12.0	694.3	2,298.0	13.0	822.2	2,721.3
Corn for Grain	Bu.	665.1	107,407.2	264,221.7	725.0	135,575.0	333,514.5
Grain Sorghum	Bu.	25.5	3,345.7	7,460.8	27.8	4,025.6	8,977.0
Silage	Ton	46.4	1,420.1	18,788.5	50.6	1,816.2	24,028.1
Alfalfa Hay	Ton	71.0	369.4	15,515.1	77.4	425.9	17,888.6
Soybeans	Bu.	2.4	111.1	560.0	2.6	132.1	665.6
Sugar Beets	Ton	11.8	246.5	8,575.0	12.9	290.5	10,105.6
Dry Beans	Cwt.	11.5	223.3	3,925.5	12.6	261.0	4,589.1
Cropland Pasture	AUM	9.4	132.2	1,585.9	10.3	154.4	1,852.2
Idle		32.5	--	--	35.4	--	--
Pasture	AUM	33.0	275.6	3,306.4	33.0	300.5	3,605.1
Nonirrigated	AUM	16.2	40.6	486.7	16.2	48.7	584.0
Irrigated	AUM	16.8	235.0	2,819.7	16.8	251.8	3,021.1
Range	AUM	2,789.0	1,673.4	20,081.2	2,789.0	1,924.5	23,093.4
Forest	AUM	39.0	18.7	224.6	39.0	21.5	258.3
Grazed	AUM	31.2	18.7	224.6	31.2	21.5	258.3
Not Grazed		7.8			7.8		
Other Agricultural Land		98.8			98.8		
Total		6,019.9		522,560.0	6,019.9		618,626.6

1/ Value is based upon Nebraska prices in Agricultural Price Standards, Water Resources Council, October, 1976, see Table VI-3.

Agricultural Land Production and Value Under Various Levels of Irrigation Development

The values for all crops outlined in the foregoing discussion are based on the medium projection of irrigation development. The adopted projection shows the acreage of irrigated land to increase from the irrigated acreage currently 578.1 thousand acres to 887.6 thousand acres by year 2000, an increase of 309.5 thousand acres. The increased value of all farm production including the value of increase from the adopted projection of irrigation development is $211.9 million.

Two other projections, one lower and one higher, were made and evaluated in addition to the one adopted for this study. The lower projection, which estimates that 732.8 thousand acres will be irrigated by year 2000, an increase of 154.7 thousand acres, will increase the value of all crop and grazing production from $310.6 million to $478.8 million. The higher projection, which estimates that 1,042.4 thousand acres will be developed for irrigation by year 2000, an increase of 464.3 thousand acres, will increase the value of production from all agricultural lands to $566.3 million. Thus, by year 2000, the value of all crop production, using constant prices, could increase by $168.2 million for the low projection and $255.7 million for the high projection as compared to $211.9 million for the adopted projection (Table VI-6).

TABLE VI-6 CROP PRODUCTION UNDER VARIOUS LEVELS OF IRRIGATION DEVELOPMENT
Republican River Basin, Nebraska

Crop	Unit	Base Year	Future Without Plan[1] 2000	Future Without Plan[1] 2020	Lower Irrigation Projection[2] 2000	Lower Irrigation Projection[2] 2020	Higher Irrigation Projection[3] 2000	Higher Irrigation Projection[3] 2020
		(Thousands)						
Wheat	Bu.	27,758.9	31,305.8	34,246.2	33,365.7	37,192.5	29,245.7	31,199.7
Rye	Bu.	173.0	223.4	247.2	239.5	270.4	207.6	224.3
Corn for Grain	Bu.	51,517.1	112,210.2	140,438.5	93,819.8	113,596.8	130,600.4	167,280.8
Grain Sorghum	Bu.	12,733.0	18,987.7	20,185.1	19,518.4	20,878.9	18,456.3	19,491.2
Silage	Ton	696.1	1,695.2	2,099.3	1,467.3	1,760.2	1,923.2	2,438.8
Oats	Bu.	374.3	484.2	535.4	518.4	585.7	450.0	485.7
Barley	Bu.	55.1	71.6	78.8	76.6	86.2	66.2	71.4
Alfalfa Hay	Ton	384.7	565.9	621.7	515.5	560.2	616.4	689.3
Other Hay	Ton	188.7	200.0	201.0	214.2	220.0	185.7	182.3
Soybeans	Bu.	95.1	153.9	173.6	137.6	151.1	169.9	196.5
Sugar Beets	Ton	131.9	246.5	290.5	203.4	232.0	289.3	349.0
Dry Beans	Cwt.	121.4	223.3	261.0	184.3	208.4	262.3	313.5
Cropland Pasture	AUM	581.1	665.0	724.7	680.0	746.6	651.0	702.8
Other Grazing	AUM	1,269.5	1,967.7	2,246.5	1,967.7	2,246.5	1,967.7	2,246.5
Total	AUM	1,850.6	2,632.7	2,971.2	2,647.7	2,993.1	2,618.7	2,949.3
Value	Dol.	310.6	522.6	618.6	478.8	554.7	566.3	682.6

1/ Future Without Plan:
Irrigated Cropland
Base - 578,068 acres
2000 - 887,600 acres
2020 - 967,600 acres

2/ Lower Irrigation Projection:
Irrigated Cropland
Base - 578,068 acres
2000 - 732,800 acres
2020 - 772,800 acres

3/ Higher Irrigation Projection:
Irrigated Cropland
Base - 578,068 acres
2000 - 1,042,400 acres
2020 - 1,162,400 acres

Projected Status of Conservation Treatment - Year 2000

Potentially, every acre of agricultural land could be used in accordance with its greatest capability and could be treated in accordance with its need. However, it is reasonable to expect that desired land treatment and proper land use will be less than the ideal goal because of such factors as land ownership changes, depreciation of mechanical practices and lag in application of conservation practices. Therefore, landowners and operators are expected to continue applying conservation measures to adequately treat and protect the land at about the same rate in the future as they have in the past years.

It is estimated that by year 2000, the land adequately treated and protected will about double to 3.8 million acres (Table VI-7). In addition to this 3.8 million, there will be 1.6 million acres of land adequately protected but would still require varying amounts and kinds of conservation measures for production purposes. There would be a total of 5.4 million acres of land adequately protected, or about 90 percent of the agricultural land in the basin would have soil loss rates within recommended soil loss tolerance rates. The acreages of land with erosion rates in excess of recommended soil loss rates would be reduced from 1,075.7 to 583.7 thousand acres.

Effect of Projected Land Treatment on Soil Losses

The application and installation of additional land treatment measures under the going program will effectively reduce sheet and rill

Conservation Tillage & Terraces Reduce Soil Erosion & Increase Infiltration

TABLE VI-7 PROJECTED STATUS OF CONSERVATION TREATMENT - Year 2000
Republican River Basin, Nebraska

Land Class	Total Acres	Adequately Treated	Adequately Protected	Needs Treatment	Needs Protection
	(Thousands of Acres)				
Cropland (Nonirr. & Irr.)					
I	283.3	199.7	283.3	83.6	0
II	1,616.8	1,070.9	1,616.8	545.9	0
III	556.1	316.4	326.3	239.7	229.8
IV	354.6	197.7	202.9	156.9	151.7
V	.4	.4	.4	0	0
VI	246.8	132.7	144.8	114.1	102.0
VII	2.1	1.0	1.0	1.1	1.1
Subtotal	3,060.1	1,918.8	2,575.5	1,141.3	484.6
Pasture and Range					
I	5.7	3.3	5.7	2.4	0
II	224.2	139.6	224.2	84.6	0
III	110.8	71.7	110.8	39.1	0
IV	261.8	176.2	261.8	85.6	0
V	4.8	3.6	4.8	1.2	0
VI	1,897.0	1,189.0	1,897.0	708.0	0
VII	317.5	212.6	218.4	104.9	99.1
VIII	.2	.1	.2	.1	0
Subtotal	2,822.0	1,796.1	2,722.9	1,025.9	99.1
Forest & Woodland	39.0	39.0	39.0	0	0
Other Agri. Land	98.8	96.7	98.8	2.1	0
Total	6,019.9	3,850.6	5,436.2	2,169.3	583.7
Percent	100	64	90	36	1.0

Note: Land "Adequately Treated" refers to agricultural lands with proper vegetative, mechanical and/or management practices applied to obtain an acceptable soil loss tolerance control and a optimum production potential. Land "Adequately Protected" refers to agricultural lands that are protected from water and wind erosion so that the rates are within the soil loss tolerance established for a specific soil.

soil losses and sediment yields. It is estimated that the increased acreages of land adequately treated and protected by 2000 will reduce the soil loss on all agricultural land to about 19.8 million tons average annual or 3.2 tons per acre for all the agricultural land. A great proportion of this soil loss would occur on about one-sixth of the cropland. The largest acreage, 225,700 of IIIe land, would have soil losses amounting to 1.9 million tons or 8.6 tons per acre (Table VI-8)

TABLE VI-8 AGRICULTURE LANDS WITH EXCESSIVE EROSION - YEAR 2000
BY LAND CAPABILITY CLASS AND SUBCLASS
Republican River Basin Nebraska

Sub-Class	All Land			Adeq. Treated			Not Adeq. Treated/Prot.		
		Ave. Ann. Soil Loss			Ave. Ann. Soil Loss			Ave. Ann. Soil Loss	
	Acres	Total Tons	Tons Per Acre	Acres	Total Tons	Tons Per Acre	Acres	Total Tons	Tons Per Acre
	---(Thousands)---			--(Thousands)---			--(Thousands)---		
Cropland (Nonirr. & Irr.)									
IIIe	538.5	2,207.8	4.1	305.2	213.6	0.7	233.3	2,006.4	8.6
IVe	348.4	2,125.2	6.1	195.6	254.3	1.3	152.9	1,896.0	12.4
VIe	228.2	4,381.4	19.2	124.5	684.8	5.5	103.7	3,691.7	35.6
VIIe	1.0	33.8	33.8	0.5	2.4	4.8	0.5	31.8	63.7
VIIs	1.1	5.9	5.4	0.4	1.0	2.5	0.6	4.4	7.3
Subtotal	1,117.2	8,754.1	7.8	626.2	1,156.1	1.8	491.0	7,630.3	15.5
Pasture & Range									
VIIe	303.9	1,671.4	5.5	204.8	655.4	3.2	99.1	1,000.1	10.1
Total	1,421.1	10,425.5	7.3	831.0	1,811.5	2.2	590.1	8,630.4	14.6

Class IVe land, 147,900 acres, would sustain soil losses to an even higher rate averaging 12.4 tons per acre; for a total of 1.8 million tons for this class of land. The greatest amount of soil loss would continue to be on Class VIe land with 100,800 acres of land eroding at a 35.6 ton per acre totaling about 3.6 million tons annually. About 1,100 acres of Class VII land would erode at rates of 7.3 to 63.7 tons per acre and sustain soil losses of 36 thousand tons. It is anticipated that the rangeland needing adequate protection would be reduced from 183,100 to 98,500 acres. Total soil losses from this rangeland will be reduced from 1.8 to about 1 million tons.

In summary, it appears that the land now adequately protected will increase by the year 2000 to the point that only 590 thousand acres, or 10 percent, of the agricultural land will have soil loss rates in excess of soil loss tolerance rates. About 83 percent of this amount is cropland. Intensive efforts will be needed to install conservation measures to provide adequate protection to these lands (Table VI-8).

Land Treatment Effects on Streambank, Gully and Roadside Erosion

Land treatment is not expected to have a significant impact on streambank erosion in the basin. Bank erosion results from flow within the channel acting upon the banks. Land treatment will reduce the volume and the flood peaks of surface runoff entering the channels. Since this reduction in runoff will only be a small portion of the total flow; the effect on bank erosion reduction will be minimal. Gully erosion will be effected in some areas of the basin, but the overall impact still will be slight. Gully Erosion, which occurs on or adjacent to cropland in the basin, can be reduced by application of land treatment to the croplands. However, this reduction represents only a small portion of the total erosion that occurs. Eroding roadsides will be reduced to 150 miles by year 2000.

Effects of Land Treatment on Sediment Yields

Sediment yields from an area depends on the soil loss as well as on the topography, drainage patterns, vegetal cover, precipitation patterns, manmade works, and stream marphology. Projected future increases in land treatment and protection will affect sediment yields in the basin. The greatest impact will be in the reduction of sheet erosion throughout the basin. The increase in land treatment will reduce sediment derived from cultivated land and to a lesser extent, from rangeland. It is estimated that the sediment derived from sheet and rill erosion will be reduced by about 1.1 million tons or a reduction of 36 percent (Table VI-9).

Sediment yields from gullies, streambanks, bedloads,and roadsides will be relatively unaffected by the land treatment program. These sediment sources are already in a higher yield, channel oriented condition where the factors of bank erosion, higher velocity, quantity of water, and steeper slopes are affected to a lesser degree by land treatment. It is estimated that the sediment delivered from these sources will be reduced by 600 thousand tons or about a 20 percent reduction at the mouths of the watersheds in the basin. Table VI-9 shows effects of land treatment on future condition sediment yields from all sources by individual watersheds in the basin. For the entire basin, by the year 2000, an average reduction of 28 percent in sediment yield, when measured at the watershed level, can be attributed to land treatment and protection.

TABLE VI-9 PROJECTED SOIL LOSSES AND SEDIMENT YIELD FROM WATERSHEDS, PRESENT AND YEAR 2000
Republican River Basin, Nebraska

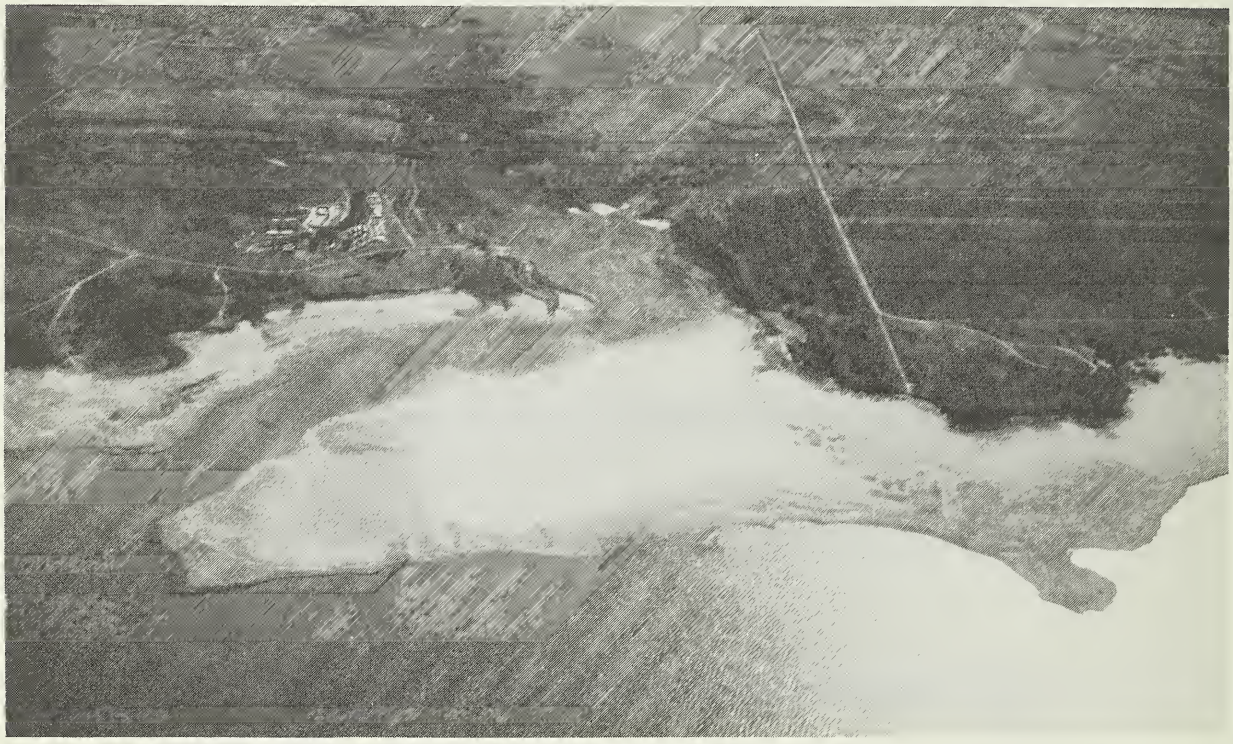
Sub-Basin	Watershed	Present				Year 2000				Total Reduction
		Sheet Erosion		Gully, Bank & Bedload	Total	Sheet Erosion		Gully, Bank & Bedload	Total	
		Gross	Delivered	Delivered	Delivered	Gross	Delivered	Delivered	Delivered	
		(Thousand Tons)								(Percent)
41a3 - 1	Sand Creek	174	14	3	17	110	9	3	12	29
- 4	Frenchman R. (Enders Reservoir)	421	38	24	62	265	24	18	42	32
41a - 1	Chase-Dundy Sand Hills	299	18	5	23	199	12	4	16	30
- 2	Indian Creek	241	34	19	53	167	23	15	38	28
- 3	Burntwood Creek	209	31	26	57	145	22	21	43	25
- 4	Muddy Creek (Dundy)	259	29	28	57	178	20	23	43	25
- 5	Culbertson-Stratton Tribs. (N)	309	37	30	67	215	26	23	49	27
- 6	Culbertson-Stratton Tribs. (S)	392	47	48	95	272	33	37	70	26
41a1 - 8	N. Fork Rep. River	34	4	7	11	23	3	5	8	27
-10	Buffalo Creek	189	15	11	26	131	10	8	18	31
-11	Rock-Spring Creeks	418	38	22	60	288	26	16	42	30
-12	Hay Canyon, Etc., Tribs.	60	12	8	20	42	8	7	15	25
41a1(a)- 8	Arikaree River	19	3	3	6	13	2	3	5	17
41a2 -13	S. Fork Rep. River	9	2	2	4	7	1	2	3	25
41a -11	Red Willow Creek (Upper)	809	57	42	99	577	40	31	71	28
-12	Red Willow Creek (Lower)	1,270	89	109	198	838	59	85	144	27
41a3(a)- 1	Venango Tr.	109	8	2	10	74	5	2	7	30
- 2	Spring Creek (Upper)	340	14	8	22	232	9	6	15	32
- 3	Grant Tr.	490	15	12	27	349	11	9	20	30
- 4	Stinking Water Creek (Upper)	740	30	22	52	521	21	16	37	29
- 5	Spring-Stinking Water Cr. (Lower)	537	27	30	57	347	17	22	39	32
41a3 - 5	Frenchman R. (Wauneta Tribs.)	363	36	33	69	236	24	25	49	29
- 6	Frenchman R. (Lower)	556	45	50	95	373	30	39	69	27
- 7	Upper Blackwood	460	23	25	48	306	15	19	34	29
- 8	Blackwood Creek	908	55	64	119	605	36	50	86	28
41a6 - 4	Prairie Dog Creek (Lower)	268	27	17	44	161	16	13	29	34
41a5 - 6	Sappa Creek	117	18	7	25	71	11	5	16	36
- 7	Sappa Creek (Lower)	824	99	58	157	498	60	44	104	34
- 8	Stamford	20	5	2	7	12	3	1	4	43
41a5a - 6	Beaver Creek	65	9	5	14	43	6	4	10	29
- 7	Beaver Creek (Lebanon)	634	89	46	135	412	58	35	93	31
- 8	Beaver Creek (Beaver City)	909	109	64	173	548	66	49	115	34

TABLE VI-9 (continued)

Sub-Basin		Watershed	Present: Sheet Erosion Gross	Present: Sheet Erosion Delivered	Present: Gully, Bank & Bedload Delivered	Present: Total Delivered	Year 2000: Sheet Erosion Gross	Year 2000: Sheet Erosion Delivered	Year 2000: Gully, Bank & Bedload Delivered	Year 2000: Total Delivered	Total Reduction (Percent)
			(Thousand Tons)								
41a4	- 1	Medicine Creek (Sandhills)	696	42	61	103	508	31	48	79	23
	- 2	Medicine Creek (Upper)	841	93	130	223	579	64	94	158	29
	- 3	Medicine Creek (Lower)	745	75	150	225	498	50	121	171	24
	- 4	Medicine-Mitchell Creeks, Etc.	504	55	103	158	321	35	77	112	29
41a	- 7	Driftwood Creek	580	70	54	124	400	48	44	92	26
	- 8	Dry Creek (South)	37	5	2	7	25	3	2	5	29
	- 9	McCook Tr.	240	29	27	56	161	19	17	36	36
	-10	Sleepy Hollow-Brush, Etc., Cr.	395	51	24	75	263	34	20	54	28
	-13	Coon Creek	316	32	30	62	210	21	25	46	26
	-14	Dry Creek (Pilot)	183	22	12	34	122	15	9	24	29
	-15	Cambridge-Bartley Tr.	151	15	10	25	100	10	7	17	32
	-16	Silver Creek	154	15	9	24	100	10	7	17	29
	-17	Rep. R. South Tr. (Furnas Co.)	774	93	57	150	467	56	46	102	32
	-18	Deer Creek	696	49	59	108	454	32	47	79	27
	-19	Muddy Creek (Frontier & Gosper)	1,009	91	96	187	654	59	79	138	26
	-20	Elk-Turkey, Etc.,	1,359	122	83	205	773	70	64	134	35
	-21	Orleans Tribs.	1,520	152	137	289	946	95	111	206	29
	-22	Turkey Creek	718	93	94	187	451	59	87	146	27
	-23	Lost Creek, Etc., Tr.	403	69	43	112	262	45	34	79	29
	-24	Sacramento Tribs.	338	30	16	46	236	21	13	34	24
	-25	Center, Etc., Tr.	757	98	108	206	495	64	87	151	27
	-26	Thompson Creek	1,311	105	170	275	872	70	135	205	25
	-27	Lohff -Oak, Etc., Creeks	696	104	96	200	430	65	75	140	30
	-28	Farmers Indian, Etc., Creeks	646	84	88	172	389	51	68	119	31
	-29	Red Cloud Tribs.	797	104	129	233	475	62	110	172	26
	-30	Minnie Creek	59	13	13	26	35	8	11	19	27
	-31	Courtland Tr.	382	57	42	99	231	35	34	69	30
	-32	Superior Tr.	1,746	262	257	519	1,065	160	213	373	28
Total			30,505	3,107	2,932	6,039	19,780	1,998	2,325	4,323	28

Projected Sediment Effects on Reservoirs

The sediment and bedload carried to the major reservoirs by the year 2000 is expected to be reduced in about the same proportion as the



Reduction of Sedimentation in Reservoirs Will Be Reduced With Land Treatment

sediment yield is reduced to the mouths of the watersheds in the basin. It is estimated that the largest percentage reduction will be to Enders Reservoir which reduced some 32 percent or 23,500 tons. The largest reduction of sediment delivered will be at the Harlan County Lake which will be reduced by 30 percent or 566,500 tons (Table VI-10). These reductions will add to the useful life of the structures.

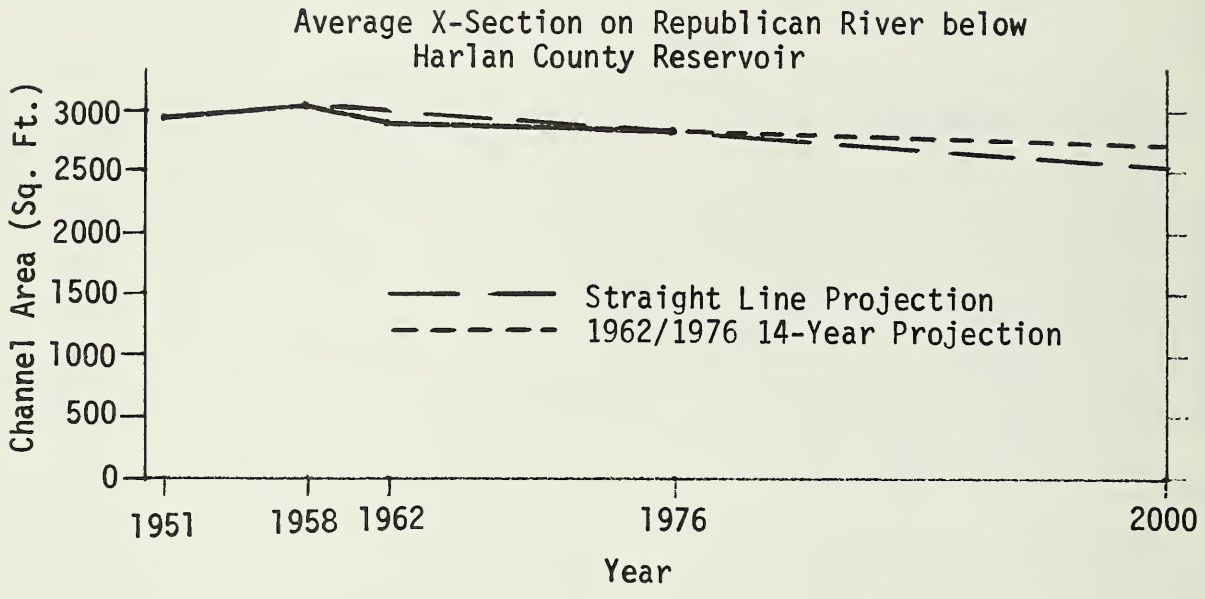
TABLE VI-10 PROJECTED SEDIMENT DELIVERIES TO SELECTED POINTS
Republican River Basin, Nebraska

Area	Current	2000	Reduction
	(Tons/Year)		(Percent)
Hugh Butler Lake	197,600	143,000	28
Harry Strunk Lake	528,500	389,000	26
Enders Reservoir	73,500	50,000	32
Swanson Lake	520,800	388,000	25
Harlan County Lake	1,862,500	1,296,000	30
Neb.-Kansas Border Below Superior, NE	1,520,800	1,093,000	28

Effect of Projected Sediment Yield on Streams

The Republican River downstream from Harlan County Lake will apparently continue to experience cycles of aggradation and degradation in response to fluctuations in the relationship between discharge and bedload supply. The channel should eventually reach a state of equilibrium, but this is not anticipated in the near future. Straight line projections based on the period of greatest change, 1958 to 1976, indicate that, on the average, as much as 300 square feet of cross-sectional area could be lost by the year 2000. Another projection based on the 25 year period, 1951,when the Harlan County Dam was closed, to 1976 indicates an average loss of a little over 100 square feet of channel area by the year 2000. Analysis of these projections indicate the average cross-sectional area of the channel is expected to be lost ranges from 100 to 300 square feet by the year 2000 (Figure VI-2).

FIGURE VI-2
PROJECTED CHANNEL AREA



Nutrient Content of Sediment Under Projected Conditions

The nutrients removed from basin lands are likely to be in about the same ratio as sediment deliveries. Although a slightly higher percentage of sediment will come from streambanks, this will not significantly alter the nutrient ratio. It is also expected that larger amounts of fertilizer will be applied to crops in the future. However, due to the costs involved, it is anticipated that most, if not all, of the fertilizer applied will be limited to the amount in the crops removed and that removed by erosion. Thus, the losses and gains will be somewhat in equilibrium. Nitrogen delivered to selected points will be reduced from 3,436 tons to about 2,446 tons, a reduction of 29 percent. In a similar manner, phosphorous delivered annually to selected points by sediment will be reduced from 255 tons to about 191 tons, a reduction of 25 percent. Similar reductions are expected to occur at each of the selected points (Table VI-11).

For the entire basin, by the year 2000, an average reduction of 28 percent in plant nutrients, measured at the watershed level, will be attributable to land treatment and protection. This will reduce the nitrogen deliveries from 4,360 tons to 3,139 tons annually, while phosphorus deliveries will be reduced from 323 tons to 233 tons.

TABLE VI-11 PROJECTED AVERAGE ANNUAL DELIVERIES OF NUTRIENTS TO SELECTED POINTS
Republican River Basin, Nebraska

Area	Present			2000		
	Sediment	N	P	Sediment	N	P
	(Tons)					
Hugh Butler Lake	197,600	69.2	4.9	143,000	50.1	3.5
Harry Strunk Lake	528,500	281.3	19.1	389,000	207.0	14.1
Enders Reservoir	73,500	25.9	0.3	50,000	17.6	0.2
Swanson Lake	520,800	150.4	9.5	388,000	112.0	17.1
Harlan County Lake	1,862,500	1,368.3	103.3	1,296,000	952.1	71.9
Neb.-Kansas Border Below Superior, NE	1,520,800	1,541.3	117.8	1,093,000	1,107.7	84.7

Floodwater Damages

Floodwater damages occurring in the basin were discussed in detail by types of damages in Chapter V, Pages V-20 through V-24. Flood plain damages are expected to continue on about 117,300 acres subject to flooding by a 100-year frequency flood. Total average annual damages under current economic conditions were estimated to be $2,196,900.

Losses from crop and pasture lands are projected to increase due to yield increases. However, there may be a small acreage of occasionally flooded bottom lands, now used for grazing, that will be converted to cropland. It is expected that this conversion will replace the productive capacity of the Class VI and VII upland cropland that is converted to permanent cover uses.

Flood losses from other land use losses are expected to remain about constant, that is, replacement of systems will equal deterioration. Future without plan conditions show increasing urban floodwater damages due to the increased value of the contents of homes that are being damaged. Average annual urban damages of $46,200 under current conditions are expected to increase to $77,900 by year 2000 (Table VI-12).

Total average annual damages, including the above urban damages, under future without project conditions are projected to increase to $2,955,800 by year 2000 and to $3,547,000 by year 2020 (Table VI-13).

TABLE VI-12 PROJECTED URBAN FLOOD DAMAGES
Republican River Basin, Nebraska

Community	Population (No)	Watershed - Name	Average Annual Damages Under Projected Economic Development: Current (Dollars)	Average Annual Damages Under Projected Economic Development: 2000 (Dollars)
Arapahoe	1,147	Muddy Cr. (Frontier and Gosper)	N	N
Bartley	283	Dry Creek (Pilot)	N	N
Beaver City	802	Beaver Creek (Lower)	N	N
Benkelman	1,349	Rock Spring Cr	6,400	10,800
Cambridge	1,145	Medicine Cr. (Below H. Strunk Lake)	N	N
Cowles	57	Red Cloud Tribs.	N	N
Culbertson	801	Frenchman River (Lower)	N	N
Curtis	1,166	Medicine Creek (Upper)	N	N
Edison	199	Elk-Turkey, Etc., Creeks	N	N
Elwood	601	Elk-Turkey, Etc., Creeks	N	N
Franklin	1,193	Center, Etc., Tribs.	N	N
Guide Rock	318	Minnie Creek	1,300	2,100
Haigler	237	Arikaree River	N	N
Hamlet	64	Frenchman River (Wauneta Tribs)	N	N
Hardy	250	Superior Tribs.	N	N
Hildreth	352	Thompson Creek	N	N
Holbrook	307	Deer Creek	N	N
Holdrege	5,635	Sacramento Tribs.	N	N
Inavale	--	Farmers, Indian, Etc., Creeks	N	N
Indianola	672	Coon Creek	N	N
Lebanon, Danbury, Marion	255	Beaver Creek (Upper)	800	400
McCook	8,285	McCook Tribs.	2,200	3,700
Madrid	234	Stinking Water Creek (Upper)	N	N
Maywood	309	Medicine Creek (Upper)	N	N
Naponee	187	Turkey Creek	800	1,400
Orleans	592	Orleans Tribs.	N	N
Oxford	1,116	Elk-Turkey, Etc., Tribs.	N	N
Palisade	372	Frenchman River (Lower)	N	N
Red Cloud	1,531	Red Cloud Tribs.	1,800	3,000
Riverton	220	Thompson Creek	1,400	2,400
Stratton	481	Culbertson to Stratton Tribs (N)	1,500	2,500
Superior	2,779	Superior Tribs.	8,200	13,800
Trenton	770	Culbertson to Stratton Tribs (N)	N	N
Venango	218	Venango Tribs.	N	N
Wauneta	738	Frenchman River (Wauneta Tribs)	21,800	36,800
Wilcox	280	Thompson Creek	N	N
Wilsonville	266	Beaver Creek (Beaver City)	N	N
Total	35,211		46,200	77,900

Note: Price Base: Current Prices 1975
N=Nominal - Large infrequent storms could cause significant damages that were not evaluated for this report.

TABLE VI-13 SUMMARY OF CURRENT AND FUTURE WITHOUT PROJECT FLOODWATER AND SEDIMENT DAMAGES
Republican River Basin, Nebraska

Watershed Number	Watershed Name	Drainage Area	Area Needing Project Action	Current Flood Damage	Average Annual Damage Future Without Project Conditions 2000	2020
		(Acres)			(Dollars)	
41a-1	Chase Dundy Sandhills	123,900	1,100	3,300	4,700	5,800
41a-2	Indian Creek	100,000	950	17,600	24,000	28,800
41a-3	Burntwood Creek	67,200	600	8,600	11,400	13,400
41a-4	Muddy Creek (Dundy Co.)	95,100	900	21,100	31,000	37,600
41a-5	Culbertson to Stratton Tribs (N)	71,500	500	10,500	12,400	14,500
41a-6	Culbertson to Stratton Tribs (S)	90,300	400	8,100	10,600	12,400
41a-7	Driftwood Creek	131,700	2,342	62,700	82,400	97,200
41a-8	Dry Creek (S)[1/]	22,800	2,300	24,200	34,600	43,100
41a-9	McCook Tribs.	45,200	1,500	22,600	32,600	40,800
	Kelly Creek[2/]	7,400	100	900	1,300	1,700
41a-10	Sleepy Hollow, Brushy etc., Creeks	86,900	800	21,800	27,600	32,400
41a-11	Red Willow Creek (Upper)	272,000	2,100	16,700	23,100	28,100
41a-12	Red Willow Creek (Lower)	235,200	1,960	32,100	44,600	54,800
41a-13	Coon Creek	60,100	864	45,500	59,700	71,500
41a-14	Dry Creek (Pilot)[1/]	35,400	1,750	26,000	36,400	44,900
41a-15	Cambridge to Bartley Tribs (N)	30,400	300	9,100	11,000	12,700
41a-16	Silver Creek	30,100	250	5,500	7,000	8,300
41a-17	Republican River South Tribs. (Furnas)	111,300	700	16,200	19,500	21,200
41a-18	Deer Creek	126,800	1,450	16,500	20,400	22,800
41a-19	Muddy Creek (Frontier & Gosper)	161,100	1,900	29,700	33,000	34,700
41a-20	Elk-Turkey, etc., Creeks	205,800	2,900	62,000	71,600	77,400
41a-21	Orleans Tribs.	238,300	4,600	52,800	69,100	82,200
	Milrose Creek[2/]	11,700	812	29,700	41,000	50,200
41a-22	Turkey Creek	106,200	2,336	70,300	92,900	109,700
41a-23	Lost Creek, etc., Tribs.	54,100	600	14,200	16,400	17,900
41a-24	Sacramento Tribs.	76,700	3,100	8,900	9,800	10,500
41a-25	Center, etc., Tribs.	99,100	1,250	28,100	32,600	35,900
41a-26	Thompson Creek	191,600	3,800	59,900	81,300	97,300
41a-27	Lohff, Oak, etc., Creeks	84,800	1,650	30,400	33,700	36,300
41a-28	Farmers, Indian, etc., Creeks	77,500	2,750	58,600	69,500	78,000
41a-29	Red Cloud Tribs.	95,800	1,300	39,700	42,200	45,800
41a-30	Minnie Creek	6,500	100	6,700	9,200	11,300
41a-31	Courtland Tribs.	35,000	250	9,100	10,100	11,000
41a-32	Superior Tribs.	146,000	2,600	85,100	96,100	108,200
41a1-8	North Fork Republican River	14,600	200	800	1,000	1,100
41a1-10	Buffalo Creek	82,100	200	2,000	3,000	3,600
41a1-11	Rock-Spring Creeks	180,200	600	9,100	15,200	19,900
41a1-12	Hay Canyon, etc., Tribs.	26,300	200	2,600	3,600	4,400
41a1(a)-8	Arikaree River	8,300	0	0	0	0
41a2-13	South Fork Republican River	3,900	0	0	0	0
41a3-1	Sand Creek	67,800	3,000	23,400	32,700	39,900
41a3-4	Frenchman River (Enders Reservoir)	164,400	2,300	14,500	18,900	21,800
41a3-5	Frenchman River (Wauneta Tribs)	102,600	1,545	29,200	46,500	60,600
41a3-6	Frenchman River (Lower)	131,400	5,120	69,300	106,600	130,700
41a3-7,8	Blackwood Creek[1/]	287,600	5,700	34,600	48,300	58,600
41a3(a)-1	Venango Tribs.	38,100	500	5,600	7,600	9,100
41a3(a)-2	Spring Creek (Upper)	113,300	1,000	5,600	8,200	10,300
41a3(a)-3	Grant Tribs.	147,400	1,000	4,900	7,500	9,600
41a3(a)-4	Stinking Water Creek (Upper)	231,000	2,750	19,600	20,500	31,700
41a3(a)-5	Spring, Stinking Water Creeks (Lower)	148,600	5,040	51,300	70,700	85,900
41a4-1	Medicine Creek (Sandhills)	230,200	1,680	2,100	3,200	4,200
41a4-2	Medicine Creek (Upper)[1/]	219,100	2,595	26,100	37,300	46,100
41a4-3	Medicine Creek (Lower)[1/]	152,700	3,974	77,300	115,900	146,500
41a4-4	Medicine-Mitchell-etc. Creeks	83,500	300	1,400	2,300	2,900
41a5-6	Sappa Creek	17,100	170	3,100	3,400	3,700
41a5-7	Sappa Creek (Lower)	119,300	9,000	252,400	352,200	412,600
41a5-8	Stamford [1/]	2,900	410	4,800	6,800	8,400
41a5(a)-6	Beaver Creek	14,300	0	1,200	1,200	1,200
41a5(a)-7	Beaver Creek (Lebanon)	125,600	7,900	249,200	347,400	426,400
41a5(a)-8	Beaver Creek (Beaver City)	129,400	9,237	290,300	411,700	508,300
41a6-4	Prairie Dog Creek	40,300	2,100	56,600	81,300	101,100
Total		6,215,500	117,335	2,196,900	2,955,800	3,547,000

1/ PL-566 and pilot watersheds installed or approved for installation of structural measures. Only remaining damages listed for these watersheds.

2/ Structural measures built by local sponors. Price base: Current normalized prices (July, 1976) for agricultural damages, 1975 prices for other damages.

Water Shortages

Shortages of surface water are expected to continue to occur at unpredictable intervals. During periods of drought as indicated by the Palmer Drought Index, Figure III-3, streamflows of many of the smaller streams will continue to decrease or cease entirely, and flows of the larger streams will be reduced. This will cause periodic shortages of water available in the irrigation storage reservoirs. This will result in reducing the amount of water delivered per acre or reducing the amount of acres irrigated from surface water supplies.

Agricultural Water Management

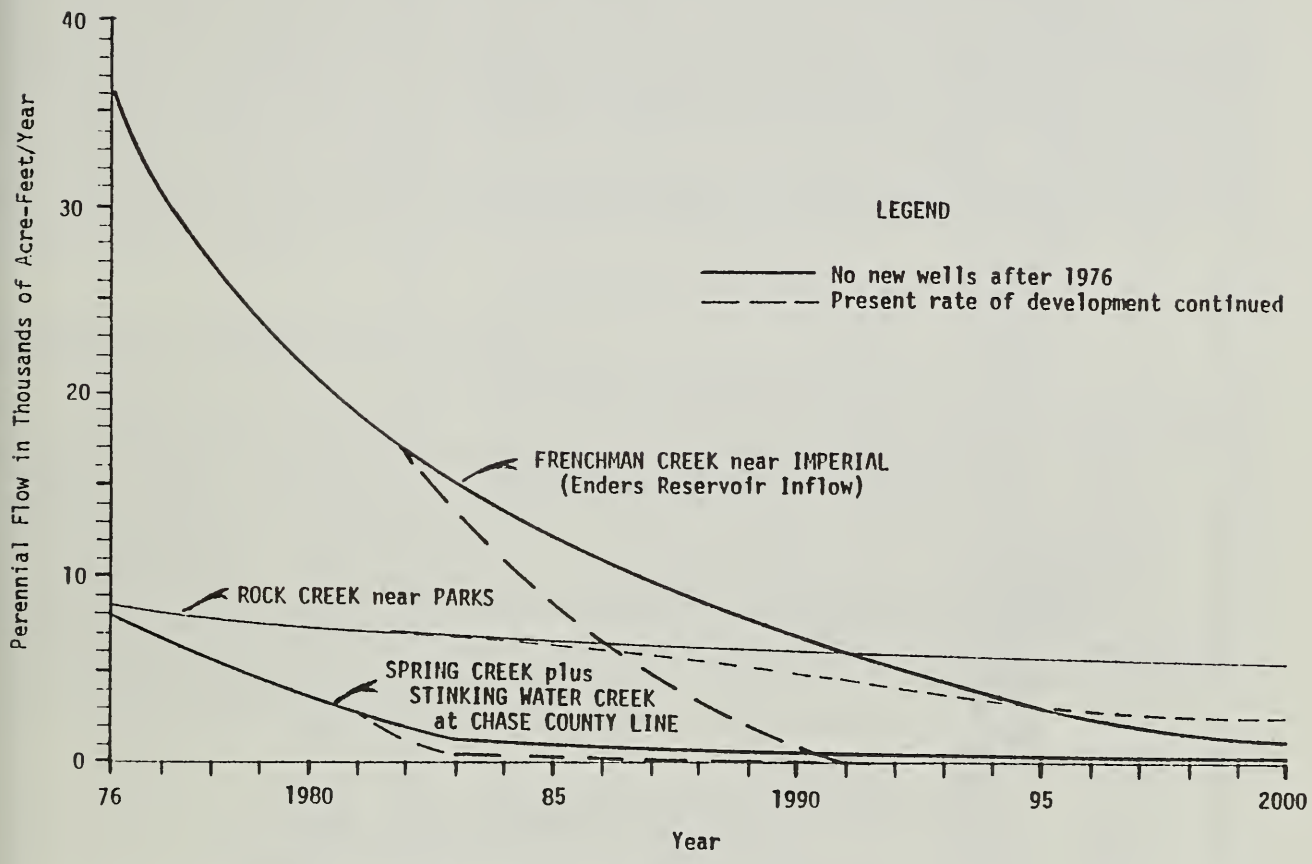
Agricultural water management in the basin is expected to improve by the year 2000. Present on-farm irrigation efficiencies are 55 percent for gravity and 65 percent for center pivot systems. By 2000, the efficiencies are expected to raise to 75 percent for gravity systems and 75 percent for center pivot systems. These increases in efficiency rates do not necessarily mean a corresponding increase in water available for irrigation or other uses. Much of the additional water being presently diverted due to low efficiency rates is either consumed at some point downstream or reverts back into the storage system. However, the increase in efficiency rates would reduce power consumption and operating cost of the systems, thus, saving energy resources while increasing profit margin for operators.

Projected Effect of Future Irrigation Development on Surface Water Supplies

A study by the U.S. Geological Survey and Conservation Survey Division, University of Nebraska, for the Upper Republican Natural Resources District area shows that streamflows have been depleted some 20 percent in the Frenchman, Stinking Water and Spring Creeks area. This is believed to be directly due to rapid development of irrigation wells pumping ground water. Depletion effects to Frenchman River, Stinking Water and Spring Creeks are projected to continue by this study. The rate and total amount of depletion should be reduced due to the enactment of a ground water control area covering these creeks by the Upper Republican Natural Resources District (Figure VI-3).

The study was made under two future conditions, and predicted changes in the base flows were made for each condition. Condition "A" assumed that there would be no further well development. Condition "B" assumed that irrigation well development would continue in the future at the rate they were developed during the 1970-1975 period. By year 2000, the well development, under condition "B", will essentially eliminate the base flows as of May 30 each year in the Stinking Water

FIGURE VI-3
PREDICTED PERENNIAL FLOW OF SELECTED STREAMS



Source: U.S.Geological Survey,Department of Interior

Creek, Frenchman Creek, Buffalo Creek, Hain Creek, and Spring Creek. Flows of 2 and 3 cubic feet per second will remain in Indian Creek and Rock Creek, respectively. Under condition "A", which assumes no more development, flows for Buffalo and Stinking Water will be 1 cfs; Frenchman near Imperial 3 cfs; Rock Creek 8 cfs; and 2 cfs for Indian Creek. Figure VI-3 shows the effect of these two rates of development on three of the streams. Other creeks in the basin could experience depletion effects from increased ground water pumping, but the locations of effect were beyond the scope of this study. However, the Bureau of Reclamation has initiated a Total Water Management Study for the Republican Basin. It is expected that this study will identify and quantify the problems in other streams and areas in the entire Republican River Basin in Colorado, Kansas and Nebraska.

TABLE VI-14 EFFECTS OF PROJECTED LAND TREATMENT AND FARM PONDS ON UPLAND SURFACE RUNOFF FOR AVERAGE YEAR CONDITIONS - YEAR 2000
Republican River Basin, Nebraska

County	Land Treatment											Computed Runoff 1975 Level	Estimated Year 2000 Runoff	Increment Depletion Year 1975 2000 2/
	Contour Only	Terraced: Contour Minimum Tillage	Minimum Tillage Only	Flat Channel Terraces	Terrace Level Contour	Irrigation	Terrace Gradient Contour	Terrace Gradient: Contour Minimum Tillage	Subtotal A	Farm Pond B	Depletion 1/ A+B			
	(Percent)											(Inches)		(Ac. Ft.)
Chase	(1.4)	0.1	1.4	1.1	(0.1)	(0.5)	0	0	0.6	5.9	6.5	0.47	0.44	1,430
Dundy	(1.5)	(0.1)	(0.6)	0.4	0.2	(0.3)	0	0	(1.9)	15.9	14.0	0.46	0.39	3,438
Franklin	0	0	0.2	0	1.4	(0.3)	0	0	1.3	12.7	14.0	1.24	0.94	8,645
Frontier	0.5	2.3	1.5	0.2	(2.9)	(0.3)	0	0	1.3	8.0	9.3	0.48	0.41	3,474
Furnas	(1.1)	0.3	0.2	1.2	(1.9)	(0.3)	0	0	(2.1)	4.1	2.0	0.64	0.62	770
Gosper	(0.7)	0.7	0.1	0	(0.2)	(0.6)	0	0	(0.7)	5.7	5.0	0.74	0.69	880
Harlan	0	0.7	0.6	(0.1)	(2.6)	(0.4)	(0.3)	0.2	(1.9)	1.9	0	1.02	1.02	0
Hayes	(2.0)	0.7	0.3	0.1	0	(0.1)	0	0	(1.6)	5.9	4.3	0.55	0.52	1,137
Hitchcock	(3.1)	1.6	(0.4)	0.4	0.7	(0.2)	0	0	(1.0)	8.2	7.2	0.58	0.53	1,925
Kearney	0	0	3.5	0	(0.1)	(0.7)	0	0	2.7	0.7	3.4	1.48	1.43	175
Keith	0	0	0.5	0.2	0.3	(0.3)	0	0	0.7	1.3	2.0	0.49	0.48	47
Lincoln	0	0	0.2	0.6	0.5	0	0	0	1.3	3.2	4.5	0.66	0.63	1,280
Nuckolls	0.1	0.3	1.4	0	1.0	(0.2)	(0.1)	0.6	3.1	6.8	9.9	1.81	1.63	1,889
Perkins	<0.1	<0.1	0.3	0	<0.1	0.3	0	0	<0.1	<0.1	<0.1	0.49	0.49	84
Phelps	0.1	0.3	7.3	0	(0.6)	(0.5)	0	0	6.6	5.4	12.0	1.15	1.00	1,863
Red Willow	0	(0.8)	0.1	5.6	(3.1)	(0.4)	0	0	1.4	1.2	2.6	0.61	0.59	763
Webster	(0.6)	0.4	0.1	0	0	(0.3)	0.1	0.1	(0.2)	8.4	8.2	1.48	1.39	3,436
Thayer	0	0	2.1	0	0	0	(2.6)	3.5	3.0	0.1	3.1	1.98	1.91	3

Note: ( ) Increase in runoff
1/ Percent based on observed runoff; increment increase between 1975 and 2000.
2/ Based on total county area in basin.

Effect of Projected Land Treatment and Farm Ponds on Surface Runoff

The application of conservation measures is expected to continue at the going rate and will affect surface runoff. It is recognized that some practices will be taken out as a result of conversion of land to irrigation and from the use of larger farm equipment. However, modification and adaptation of conservation measures to these changed conditions is expected to reestablish steady progress in the installation of conservation measures. Many of these measures will continue to have an adverse effect on surface water runoff from small upland areas. It is estimated that the depletion by year 2000 from the expected installation of conservation measures and farm ponds will deplete surface runoff by an additional 31,239 acre feet annually (Table VI-14).

Projected Livestock Water Needs

Based on the expected increase in livestock production, livestock water needs for consumption are projected to increase from 10,260 acre feet per year currently to 13,190 acre feet in 2000 (Table VI-15). Obtaining this increased supply of water is not expected to present a serious problem. Ground water will remain the principal source of livestock water. The number of livestock water dams is projected to increase to keep pace with the increased livestock water demand. Furthermore, the size of dams is expected to increase slightly as ponds are located downstream to collect water from larger drainages in order to increase their dependability.

TABLE VI-15 ANNUAL LIVESTOCK WATER USE
Republican River Basin, Nebraska

Item	Unit	Current	2000
Water Consumption			
Annual Use	Ac. Ft.	10,260	13,190
Ground Water	Ac. Ft.	6,670	8,570
Surface Water	Ac. Ft.	3,590	4,620
Evaporation			
Livestock Ponds	Number	8,968	13,000
Surface Area	Acre	12,160	18,800
Annual Evaporation	Ac. Ft.	30,000	46,600
Total Annual Use	Ac. Ft.	40,260	59,790

Projected Municipal, Industrial and Rural Domestic Water Supplies

There have been no current problems identified on which to base projected system requirements. Efficiency can be improved in some instances, and upgrading of the quality of service rendered will undoubtedly occur. Additionally, technological developments are expected to make it possible for some communities to install new services or to improve existing ones. However, due to the inability to identify any specific community need at this time, no projection of future requirements is made. It is expected that maintenance and replacement as needed of the present systems will continue to provide adequate services to the residents of the basin.

There have been about four communities in the basin that have had increase in some of their wells in the concentration of nitrates in the ground water used for drinking water above maximum desirable levels of 10 ppm. These wells seem to be isolated cases with specific causes rather than occurring with any generalized pattern. Usually, abandoning the well and developing a new supply has rectified or will rectify the problem. However, there has been a general rise in the concentration of nitrogen in ground water. Regular monitoring of nitrogen content will be required to insure a safe supply of drinking water from ground water sources. There may be other wells develop unsafe levels of nitrate content, but the lack of any pattern in those discovered to date with excessive nitrate levels make it impossible to project the number or location of these possible contaminated wells that may occur in the future.

The population in the basin is expected to decrease to a little under 60,000 during the period 1975 to 2000. At the same time, it is expected that water usage will increase by about 10 gallons per person from about 105 to 115 gallons per day. Consequently, water usage for municipal, industrial and rural domestic uses will decrease slightly from 7,500 acre feet currently to 7,300 acre feet annually by 2000.

Water Use

The average water use in the basin for beneficial purposes is expected to increase substantially by the year 2000. It is projected that the water use for the selected purposes will almost double, increasing from 915 thousand acre feet to 1.76 million acre feet, an increase of 92% (Table VI-16). About 95 percent of this increase will be due to the expected increase in irrigated lands by nearly 310 thousand acres. Although field irrigation efficiency is expected to improve significantly, consumptive use of irrigation water is expected to rise from 761.8 acre feet to 1,568.6 acre feet annually. The application of land treatment practices, such as minimum tillage, eco-fallow systems and the like, is expected to reduce surface water yields from small watersheds from 27.9 to 32.1 thousand acre feet by year 2000. This is about one-half of one percent of the total increase in water use.

TABLE VI-16 ESTIMATED WATER USE BY SELECTED PURPOSE CURRENT AND PROJECTED
Republican River Basin, Nebraska

Purpose	Current	2000	Increase
	(Thousands of Acre Feet)		
Irrigation 1/	761.8	1,568.6	806.8
Livestock 1/	10.3	13.2	2.9
Farm Ponds & Small Reservoirs	55.9	86.0	30.1
Large Reservoirs 2/	46.0	46.0	0
Types 4 & 5 Wetlands	5.7	5.7	0
Municipal 1/			
Industrial and Rural Domestic	7.5	7.3	(0.2)
Land Treatment 3/	27.9	32.1	4.2
Total	915.1	1,758.9	843.8

1/ Consumptive use does not reflect other losses such as evaporation, canal seepage, etc. Amounts based on current and projected irrigated acres used in this report (Table VI-1).

2/ Surface evaporation = (.7) (max: surface area) (Net lake evaporation)

3/ While not specifically a use, these figures are shown to signify reduction of surface runoff from upstream small watershed conservation measures.

Projected Waste Water and Sewage Treatment Facilities

There have been no current problems identified on which to base any projection requirements. As with water supplies, it is expected that advances in technology will make it possible to improve existing services. However, since specific needs cannot be identified at this time, no projection of future requirements has been made. A program of maintenance and replacement is expected to provide adequate services to basin residents.

Water Quality

It is projected that most measured Water Quality parameters (Table V-18) will not change significantly by the year 2000. Sediment, however, is projected to be reduced from the current 6.0 million tons delivered to streams annually to 4.3 million tons. The amounts of

nitrogen and phosphorous contained in these sediments will also be reduced from 3,436 and 255 tons annually to 2,446 and 191 tons, respectively. This will reduce nutrient and turbidity levels of the streams and reservoirs thereby adding to the useful life of these reservoirs. Water Quality may further improve with the implementation of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) which requires the elimination of point and non-point sources of pollution by 1985. Presently, the State is preparing a plan under Section 208 to address non-point source pollution problems including agricultural runoff (sediment, pesticide and herbicides), irrigation return flows, roadside erosion, agricultural chemicals leaching into the ground water, and streambank erosion. This plan should be completed by July of 1979.

Projected Forest and Woodland Management

Active and effective tree planting programs of local organizations may slow the loss of forest and woodland in the basin. Although professional opinion varies, one projection is that these programs will result in a tree planting program of about 7.38 million trees on approximately 30,000 acres (29,520) by year 2000. Consequently, forest and woodland acreage is expected to decrease to 39,000 acres, a net loss of only 1,000 acres by year 2000.

Although, it is expected that the acreage of woodland will stabilize at about this amount, wooded areas are expected to continue to be used primarily for grazing, to serve as stringers along streams to stabilize the banks, windbreaks and wildlife habitat. Commercial production of forest products is not expected to increase materially. Some increase for fuel uses may occur.

Range and Forest Fires

It is anticipated that the occurence of range fires will decrease from the current period by year 2000. Rural firefighting organizations have been formed in recent years and furnished with modern firefighting equipment designed to better combat wildfires. Consequently, it is estimated that the number of instances will decrease to about 150 per year and average burning 4,000 acres of rangeland annually, a 20% decrease from current levels.

Recreation

Shortages of recreation opportunities will continue to occur in the public sector if additional facilities are not provided. Increased demands for recreational facilities will result in overuse of available resources and cause soil erosion, decreased water quality and damages to facilities.

The private sector is expected to provide most of the recreational opportunities for golfing, horseback riding, sports events, commercial attractions and hunting. The public sector will be expected to provide recreational opportunities usually found in public parks and recreation areas. These will include: swimming, camping, picnicking, boating, fishing, hunting, waterskiing, and historical sites.

Future recreation, fishing and hunting conditions are shown on Table VI-17. Currently, only camping and pheasant hunting are in short supply, and this shortage is expected to increase through the year 2000. Picnicking and quail hunting shortages appear in year 2000. Expansion of picnicking and camping facilities is underway and expected to meet the increased demand. Hunting shortages will have to be alleviated by the establishment and improvement of more wildlife habitat by private landowners.

TABLE VI-17 RECREATION, FISHING AND HUNTING FUTURE WITHOUT CONDITIONS
Republican River Basin, Nebraska

Activity	Percent of Population Participating 1/	Number of Times of Annual Participation 1/	Current Annual Activity Demand (No. of Recreation Visit)	% of Annual Activity Demand Occurring on Peak Days (No./Season)	Peak Capacity of Existing Areas	Current Ann. Activity Demand Occurring on Peak Days	Year 2000 Activity Demand Occurring on Peak Days
					(Recreation Visits)		
Swimming (Beach)	30.3	6.8	292,120	40% (12 Days)	167,280	116,848	127,207
Picnicking	60.0	5.0	425,340	60% (21 Days)	278,250	255,200	292,495
Camping	38.0	8.6	463,340	50% (31 Days)	180,296	231,670	318,497
Power Boating	22.3	8.6	271,910	65% (28 Days)	266,784	176,740	203,106
Waterskiing	10.5	5.0	74,430	65% (28 Days)	133,392	48,380	75,981
Fishing (Lakes, Ponds or Reservoirs)	38.0	10.4	560,320	30% (27 Days)	571,050	168,100	173,333
Fishing (Rivers and Streams)	20.0	10.0	283.560	30% (27 Days)	110,781	85,070	83,028
					(Hunter Days)		
Hunting 2/			Curr.Ann.Demand		Available		Demand Yr.2000
Pheasant	16.3	8.0	178,264	--	130,900	--	216,589
Quail	10.0	6.0	75,892	--	91,463	--	92,784
Dove	10.0	5.6	68,409	--	84,654	--	83,835
Cottontail	3.3	5.4	23,236	--	125,471	--	27,992
Deer	4.2	4.5	23,088	--	27,060	--	23,814
Total			368,890		459,548		

1/ Date from Nebraska SCORP, 1973, and Nebraska Game and Parks Commission.
2/ Date unavailable to compute need for waterfowl or squirrel hunting. Methodology to compute hunting data comes from the Platte Level B, Fish and Wildlife Technical Paper, Appendix A.

Fish and Wildlife

Wildlife has declined dramatically in the years following the soil bank era (Table IV-24, Upland Game Harvest by Resident Hunters, 1960-1976). Fisheries resources are threatened with diminished streamflows, streambank erosion and sediment problems. The sponsors have

identified various fish and wildlife habitat needs for the basin, and these are shown on Table VI-18, Fish and Wildlife Habitat Future Conditions Without a Plan.

TABLE VI-18 FISH AND WILDLIFE HABITAT FUTURE WITHOUT A PLAN
Republican River Basin, Nebraska

Component	Unit	Current Needs	W/out Plan Contribution by Year 2000	Need or Opportunity
Upland Wildlife Habitat				
Critical Areas Treated	Acres	19,485	5,588	13,897
Canyon-Shrub Habitat Protected	Acres	58,455	13,530	44,925
Center Pivot Corners	Acres	14,540	2,376	12,164
Other Habitat	Acres	109,187	32,142	77,045
Stream Fisheries Improvement				
Warm Water Fisheries	Miles	67	7	60
Cold Water Fisheries				
Fencing & Streambank Protection	Miles	24	4	20
In Stream Mechanical Practices	Miles	20	0	20
Accelerated Land Protection	Acres	84,700	30,500	54,200
Floodwater & Sediment Structures	Each	4	--	4
Impoundment Removal	Each	1	--	1
Wetlands				
Private Land Leases (Waterbank) Cons. Practices to Protect	Acres	1,752	450	1,302
Riparian Habitat Protection	Acres	40,000	3,300	36,700
Irrigation Reuse Pits - Pit banks seeded to native grasses & Legumes and managed for waterfowl.	Acres	840	330	510

The needs as expressed by the sponsors will result in restoring fish and wildlife populations to a level above the current demand for fishing and hunting (Table VI-17), but they feel that improved fish and wildlife populations will generate an increased demand as hunting and fishing success improves.

Unique Archaeological, Historical, Cultural and Ecological Sites

Although the data for the unique historical installations and areas are incomplete, about 100 have been identified. Some of these installations or areas could be diminished by economic pressure and need for other uses. It is imperative that these areas be preserved for the benefit of the public. It is difficult to project the number of sites that will be surveyed and identified in the next 25-50 years. However, it would be reasonable to expect that the number of sites with unique values will be doubled in that period.

The Nebraska State Historical Society is well organized. The present system, along with improvements they have planned, is expected to continue to provide adequate identification of unique archaeological, historical and ecological sites during the next 25 years. The Game and Parks Commission is also equipped to adequately identify unique ecological values that will need attention. These agencies will be able to provide the identification of the unique items needing preservation, protection, restoration, or improvement.

Impairment of Natural Beauty

It is anticipated that the natural beauty of the Republican Basin will be improved in the future. Evidences of severe erosion will decrease as conservation, rural clean water, wildlife area development, and other programs bring about reduced erosion. The recent increased public awareness of the degrading effect that litter, particularly hard waste such as car bodies, worn and discarded machinery, bottles, and cans, has on natural beauty is expected to continue or even to grow. As a consequence, lesser amounts will be deposited or left to mar the landscape. Activities of local community groups in beautification activities are also expected to increase. Not much change is expected in the effect flooding has on marring the flood plain.

CHAPTER VII
REMAINING NEEDS AND OPPORTUNITIES

Introduction

If national and local objectives for economic development are to be met, and if environmental quality objectives and desires for future time frames are to be realized, then certain programs need to be accelerated or initiated, and certain projects need to be installed. Remaining needs and opportunities as defined in this chapter are those parts of the components of objectives identified and quantified in Chapters IV and V that will not be met by existing programs applied at current rates described in Chapter VI. The component needs and opportunities include items for future production of the basin's share of food and fiber, improvement of environmental conditions, improvement of economic opportunity, and increased security from natural hazards.

The remaining needs and opportunities, Table VII-1 and VII-2, include specific component items, minus parts of the items that will be met by ongoing programs by year 2000.

TABLE VII-1 NATIONAL ECONOMIC DEVELOPMENT NEEDS - YEAR 2000
Republican River Basin, Nebraska

Component	Unit	Need or Opportunity
Flood Damage and Sediment Reduction	1976 Dollars	2,955,800
Irrigation - Medium Projection	Acres	309,532
Higher Projection	Acres	464,332
Lower Projection	Acres	154,732
Livestock Water	Acre Feet	2,900
Outdoor Recreation		
Hunting Days		
Pheasants	Hunter Days	85,689
Quail	Hunter Days	1,321
Camping 1/	Recreation Visits	138,201
Picnicking 1/	Recreation Visits	14,245

1/ Additional camping and picnicking facilities are currently being installed at the Harlan County Lake by the Corps of Engineers. The Nebraska Game and Parks Commission is installing additional facilities at the Swanson Reservoir, Medicine Creek Reservoir and the Red Willow Reservoir. These installations will meet the year 2000 recreation visit demand.

TABLE VII-2 ENVIRONMENTAL QUALITY NEEDS - YEAR 2000
Republican River Basin, Nebraska

Component	Unit	Need or Opportunity
Roadside Erosion Control	Miles	150
Upland Wildlife Habitat Improvement		
Critical Areas Treated	Acres	13,897
Canyon-Shrub Habitat Protected	Acres	44,925
Center Pivot Corners	Acres	12,164
Other Habitat	Acres	77,045
Stream Fisheries Improvement		
Warm-Water Fisheries	Miles	60
Cold-Water Fisheries		
Fencing & Streambank Protection	Miles	20
In-Stream Mechanical Practices	Miles	20
Accelerated Land Protection 1/	Acres	54,200
Floodwater and Sediment Control Structures	Each	4
Impoundment Removal	Each	1
Wetlands Protection and Improvement		
Private Land Leases	Acres	1,302
Riparian Habitat Protection	Acres	36,700
Irrigation Reuse Pits Seeding	Acres	510
Conservation Treatment and Protection Needs		
Needs Treatment	Acres	2,169,300
Needs Protection	Acres	583,700
Class III Cropland	Acres	229,800
Class IV Cropland	Acres	151,700
Class VI Cropland	Acres	102,000
Class VII Cropland	Acres	1,100
Class VII Pasture & Rangeland	Acres	99,100
Sheet Erosion, Gross	Tons	19,780,000
Sheet Erosion, Delivered	Tons	1,998,000
Gully, Bank and Bedload, Delivered	Tons	2,325,000
Water Quality Improvement		
Sediment	Tons	4,323,000
Nitrogen	Tons	3,139
Phosphorus	Tons	233

1/ This accelerated land protection item is included in the Conservation Treatment and Protection Needs items below.

Remaining Commodity Needs

Projected crop production resulting from increased irrigation will be adequate to satisfy the OBERS E' projections for the basin. Some production adjustments will be necessary between crops, both nonirrigated and irrigated, to approximately achieve the balance. Data taken from Tables IV-21 and VI-6 are presented again in Table VII-3 to show their comparison.

TABLE VII-3 COMPARISON OF OBERS PROJECTIONS AND FUTURE WITHOUT PLAN SITUATION - YEAR 2000
Republican River Basin, Nebraska

Commodity	Unit	OBERS E' Projections	Production Based Upon Current Trends	Deficit or (Surplus)
		(Thousands)		
Wheat	bu.	36,749.8	31,305.8	5,444.0
Rye	bu.	496.2	223.4	272.8
Corn, grain	bu.	89,338.2	112,210.2	(22,872.0)
Silage	ton	753.0	1,695.2	(942.2)
Grain Sorghum	bu.	26,917.6	18,987.7	7,929.9
Oats	bu.	191.1	484.2	(293.1)
Barley	bu.	7.9	71.6	(63.7)
Hay	ton	810.4	765.9	44.5
Soybeans	bu.	181.2	153.9	27.3
Sugarbeets	ton	148.3	246.5	(98.2)
Dry Bean	cwt	100.7	223.3	(122.6)

CHAPTER VIII
ALTERNATE PLANS

Introduction

Separate plans emphasizing national economic development and environmental quality were formulated and are described in this chapter. Other structural alternatives which were considered are also discussed at the end of this chapter. Elements from these plans were evaluated and through trade-off and change, formulated into the preferred plan presented in Chapter IX. The planning objectives, goals and constraints, criteria and procedures, discussed in previous chapters were basic for formulation of the plans.

Plans were formulated to respond to the problems and needs remaining after considering the "without plan" conditions as summarized in Chapter VII. In estimating the future conditions without a plan, as well as formulating the National Economic Development (NED) and Environmental Quality (EQ) Plans, consideration was given to all means of fulfilling the needs, both structural and nonstructural. For the NED Plan, most elements were structural. Most of the nonstructural elements are included in the EQ Plan where many of the programs are legal or institutional in nature.

Expected impacts or effects of the various plan elements were analyzed from three viewpoints or accounts: (1) economic; (2) environmental; and (3) social well-being. Beneficial effects in the economic development account reflect increased production of goods and services and/or gains in production efficiency. Benefits are presented on an average annual basis. Adverse effects in the economic account reflect the value of land acquisition, project development plus operation, maintenance and replacement. Federal and regional cost shares are estimated and displayed in the accounts.

Effects displayed in the environmental account reflect favorable and deleterious contributions to the environment from the implementation of a plan element. Effects in the social well-being account reflect impacts of the plan element on the amount and distribution of income, employment, health and safety, education, cultural and other social activities. Since the nature of an environmental and social well-being effect--whether beneficial or adverse--is often a personal judgment, no distinction is made on the nature of an effect in the accounts.

Direct and indirect employment effects are shown in the following account tables as man-years of employment associated with various natural resource developments. The man-years of employment available during construction or installation periods may be filled by local workers or by workers from other areas depending upon unemployment and under-employment conditions in the basin as well as matching job requirements

with skills of the workers. Job opportunities seized by non-local workers will provide little, if any, net gains in national economic development because local benefits will be offset by the displacement effects felt in other areas.

National Economic Development Plan

This plan was formulated to enhance national economic development by increasing the value of the nation's output of goods and services and improve national economic efficiency. Fully implemented, this plan would:

1. Reduce flood damages on about 1,680 acres of agricultural land.

2. Create opportunities for an additional 42,200 hunter-days for pheasants and 1,000 hunter-days for quail.

Environmental Quality Plan

This plan outlines programs and developments that would provide for the protection and enhancement of the environment. The impacts of effects of each element are described under the three accounts previously mentioned. Fully implemented, this plan would:

1. Reduce erosion along 150 miles of road.

2. Protect and enhance 1,300 acres of wetlands.

3. Reduce erosion on 583,700 acres.

4. Improve fishery on 60 miles of warm water streams.

5. Enhance wildlife habitat in critical source areas.

6. Enhance existing canyon shrub habitat.

7. Establish 12,200 acres of wildlife habitat in center pivot corners.

8. Establish or renovate habitat on about 77,000 acres.

9. Utilize 510 acres of irrigation reuse pits for waterfowl and wildlife.

10. Improve cold water fishery in Rock, Buffalo, Elm, and Thompson Creeks.

11. Preserve and protect 36,700 acres of riparian woodlands.

12. Continue system of monitoring sediment deposition downstream from Harlan County Dam.

Display Accounts

Following are the display accounts for the NED and EQ Plans.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Reduce flooding on cropland.

PLAN ELEMENT - Install two floodwater retarding structures in Coon Creek Watershed and 6,600 feet of floodway in Milrose Creek.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	Average Annual
Total flood prevention benefits	$66,000
1. Agricultural benefits	51,500
2. Nonagricultural benefits	14,500

ADVERSE EFFECTS 1/	Total Cost	Average Annual Cost REGION	Average Annual Cost REST OF NATION
1. Structure installation cost	$412,000	-	$29,380
2. Landrights	150,000	$10,700	-
3. Engineering service and project administration	157,000	600	10,600
4. Operation, maintenance and replacement		3,000	
Subtotal	719,000	14,300	39,980
Total Adverse		$54,280	
Net Beneficial Effect		+$11,720	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Withhold 900 acre-feet of sediment.
2. Mitigate 7 acres of wildlife habitat.
3. Reduce sediment and scour damages.
4. Provide approximately 175 acres of grass and herbaceous wildlife cover on dams and in dry sediment pools.
5. During construction:
   a. Increase possible sediment deposition downstream.
   b. Increase dust and noise pollution.
   c. Increase fuel consumption.
   d. Disrupt wildlife population.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase vehicular traffic in construction vicinity.
2. Reduce flooding on 1,680 acres of cropland.
3. Can provide as many as 15 man-years of direct and indirect employment during construction period. 2/

1/ Total costs shown in line item amortized @ 6 7/8 percent for 50 years.
2/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Increase outdoor recreation opportunities.

PLAN ELEMENT - Improve game bird habitat and increase populations, thus, providing opportunities for an additional 42,200 hunter-days for pheasants and 1,000 hunter-days for quail.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/	Average Annual	ADVERSE EFFECTS 2/
Hunter-day benefits	$129,600	Costs not determined

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase vehicular traffic in basin, thus, increasing noise and dust pollution.
2. Increase chance of disturbance to other game and nongame populations.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase opportunity for firearm related accidents and injury.
2. Increase opportunity for accidental fires.
3. Can provide as many as two man-years of direct and indirect employment per year.

1/ Benefits based on 43,200 hunter-days at $3.00 per day (42,200 hunter-days for pheasants and 1,000 hunter-days for quail). Installation of the EQ Plan will provide an estimated 14,100 additional hunter-day opportunities for quail.

2/ The actual costs for this plan element are indeterminable. The needs identified in Chapter VII for pheasant hunter-days will be partially met by installation of the EQ plan elements, and all projected needs for quail hunting will be easily satisfied. The EQ elements, which will provide most of the hunting opportunities, are Nos. 1, 2, 3, 5, 6, 7, 8, 9, and 11 as listed on page VIII-2.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Reduce erosion along 150 miles of road.

PLAN ELEMENT - Seed, mulch, stabilize and manage erosive roadside areas.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total installation Costs	$135,000	$135,000
Total Installation Costs		$270,000

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality in streams.
2. Create roadside wildlife habitat.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase frequency of wildlife on roads.
2. Increase chance of vehicle-firearm accidents.
3. Enhance visual quality of roadsides.
4. Enhance fire hazard along roads.
5. Can provide as many as three man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Protect and enhance 1,300 acres of wetlands.

PLAN ELEMENT - Lease and fence wetlands.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Cost of Leases 1/	$390,000	$97,500
2. Technical Assistance	1,950	650
Subtotal	391,950	98,150

Total Installation Costs $490,100

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Preserve wetlands for wildlife habitat and waterfowl production.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Preserve wetlands for production of wildlife and waterfowl for human recreation.
2. Provide possibility of outdoor classrooms.
3. Enhance production of pest insects.

1/ Total value of 25-year leases.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Reduce water and wind erosion on 583,700 acres.

PLAN ELEMENT - Manage 99,100 acres of pasture and rangeland, install 17,570 miles of terrace, install 13,200 acres of waterways, change land use on 103,100 acres.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

Accelerated land treatment not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total Installation costs of land treatment	$8,132,700	$24,397,900
2. Technical assistance	-	6,110,900
Subtotal	8,132,700	30,508,800
Total Installation Costs	$38,641,500	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion on 583,700 acres to less than 5 tons/acre/year.
2. Improve water quality in streams, rivers and reservoirs by reducing sediment concentrations.
3. Decrease agricultural nutrient contributions to streams, rivers and reservoirs.
4. Improve quality of aquatic ecosystems.
5. Enhance wildlife resources.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance visual quality of landscape.
2. Increase wildlife habitat and population for human recreation.
3. Improve water quality for all purposes.
4. Can provide as many as 658 man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Improve warm water fishery.

PLAN ELEMENT - Treat critical sediment sources; install fencing for livestock exclusion; establish woody and herbaceous bank plantings on 7 miles of Stinking Water Creek, on 20 miles of Upper Stinking Water and Spring Creeks, on 19 miles of Medicine Creek,and on 14 miles of Red Willow Creek. Investigate and encourage possible legislative action to establish minimum flows in streams.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS	REGION	REST OF NATION
1. Total Installation costs	$71,100	-
2. Technical Assistance	7,500	$2,500
Total Installation Costs	$81,100	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality for fish by reducing sedimentation.
2. Improve fish cover with bank vegetation.
3. Improve wildlife habitat on banks.
4. Increase sediment in streams during installation of bank plantings.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve visual quality of streambanks.
2. Improve fishery resource for human recreation.
3. Reduce landowner rights on treated streams.
4. Can provide as many as three man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Enhance wildlife habitat in critical source areas throughout basin.

PLAN ELEMENT - Treat critical areas by establishment of vegetation and fencing on 13,900 acres.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total Installation Costs	$2,224,000	$6,672,000
2. Technical Assistance	27,800	111,200
Subtotal	2,251,800	6,783,200
Total Installation Costs		$9,035,000
3. Reduced grazing production per year	$33,400	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Reduce wind and water erosion by establishment of vegetative cover protected by fencing.
2. Provide food supply and winter cover for wildlife.
3. Improve downstream water quality.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance visual quality of landscape.
2. Increase wildlife habitat and population for human recreation.
3. Can provide as many as 162 man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Enhance existing canyon shrub habitat.

PLAN ELEMENT - Lease 45,000 acres of shrub habitat, thus, protecting its wildlife value.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Cost of leases[1/]	$3,375,000	-
2. Technical assistance	72,000	$18,000
Subtotal	3,447,000	18,000
Total Installation Costs	$3,465,000	
3. Reduced grazing production per year	$162,000	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Provide food supply and winter cover for wildlife.
2. Improve habitat for non-game species.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve hunting by decreasing winter mortality losses.
2. Decrease livestock grazing.
3. Can provide as many as two man-years of direct and indirect employment during construction period.[2/]

1/ Total value of ten-year leases.
2/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Utilize center pivot corners for wildlife habitat.

PLAN ELEMENT - Establish 12,200 acres of wildlife habitat in center pivot corners.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total cost of seeding and fencing	$610,000	$1,830,000
2. Technical assistance	12,200	12,200
Subtotal	622,200	1,842,000
Total Installation Costs		$2,464,400
3. Reduced crop and grazing production per year	$988,200	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Decrease energy consumption by reducing vegetative maintenance.
2. Create 12,200 acres wildlife habitat.
3. Reduce wind and water erosion.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase wildlife habitat and population for human recreation.
2. Increase fire hazard.
3. Improve vehicle driver visibility by reducing wind erosion.
4. Can reduce employment as much as 33 man-years annually due to decreased agricultural production.
5. Can provide as many as 45 man-years of direct and indirect employment during period of renovation. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Protect, create, manage and improve wildlife habitat throughout basin.

PLAN ELEMENT - Establish grasses, legumes, trees and shrubs on about 55,350 acres. Improve and renovate habitat on about 21,650 acres.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Establish new habitat	$3,736,000	$11,208,000
2. Renovate existing habitat	1,083,000	3,247,000
3. Technical assistance	30,800	123,200
Subtotal	4,849,800	14,578,200
Total Installation Costs	$19,428,000	
4. Reduced grazing production per year	$78,000	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality by reducing sediment movement.
2. Improve quality of wildlife habitat.
3. Increase food supply and winter cover for wildlife.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase wildlife population for human recreation.
2. Change visual appearance of landscape.
3. Can provide as many as 380 man-years of direct and indirect employment during construction period. 1/
4. Can reduce employment as much as three man-years annually due to decreased agricultural production.

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Increase value of irrigation re-use pits for waterfowl and other wildlife.

PLAN ELEMENT - Establish grasses; stabilize banks; manage water levels; install fencing on about 510 acres of irrigation re-use pits and adjacent lands.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total installation costs	$25,500	$76,500
2. Technical assistance	255	765
Subtotal	25,755	77,265
Total Installation Costs	$103,020	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance use of pits by waterfowl for nesting and resting.
2. Establish wildlife habitat.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance visual quality of re-use pits.
2. Limit livestock use of pits.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Improve cold water fishery in Rock Creek, Buffalo Creek, Elm Creek and Thompson Creek.

PLAN ELEMENT - Install fencing and streambank protection to 20 miles of streams; install in-stream mechanical practices on 20 miles of streams; construct four floodwater sediment reduction structures on Thompson Creek; remove old dam on Rock Creek.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Install streambank protection and in-stream practices.	$ 33,300	-
2. Technical assistance for (1).	6,000	$ 2,000
3. Remove old dam on Rock Creek.	15,000	-
4. Technical assistance for (3).	500	2,500
5. Install four dams on Thompson Creek.	-	1,669,000
6. Engineering services and project administration for (5).	50,000	651,000
7. Land rights for (5).	1,025,000	-
Subtotal	1,129,800	2,324,500
Total Installation Costs	$3,454,300	
8. Reduced crop and grazing production per year.	$ 182,000	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality by reducing sedimentation.
2. Improve fish cover with bank vegetation.
3. Improve wildlife habitat on banks.
4. Create spawning areas for trout.
5. Decrease water quality during short term installation of practices.
6. Mitigate 50 acres of habitat.
7. Retain 3,000 acre feet of sediment.
8. Reduce sediment in Thompson Creek and Republican River.
9. Create additional ground water recharge source.
10. Reduce flooding on 3,800 acres of cropland.
11. Reduce water temperature in Rock Creek stream and lake.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase fish population for human recreation.
2. Change visual landscape.
3. Eliminate 500 acres irrigated (center pivot) cropland.
4. Close one road.
5. Improve visual quality of streambanks.
6. Can provide as many as 58 man-years of direct and indirect employment during construction period.1/
7. Reduce landowner rights on treated streams.
8. Can reduce employment as much as 6 man-years annually due to decreased agricultural production.

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Preserve and protect riparian woodland.

PLAN ELEMENT - Lease 36,700 acres of riparian woodlands.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Cost of leases[1/]	$9,175,000	
Total	$9,175,000	
2. Reduced grazing production per year.	$ 264,200	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase wildlife habitat value of woodlands.
2. Improve growth and vigor of remaining forest land.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECT

1. Improve visual quality of forest land.
2. Reduce landowner use of woodlands.

1/ Twenty-five year lease.

ENVIRONMENTAL QUALITY PLAN

STUDY OBJECTIVE - Establish monitoring system of sediment deposition downstream from Harlan County Dam.

PLAN ELEMENT - Establish additional degradation ranges on Republican River and on major tributaries to determine sediment disposition. Study possible effects of large structural system on sediment deposition, fishery resource, wildlife habitat, flood damage reduction and social acceptance.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS
Not evaluated.

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

None

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

None

Other Structural Considerations

Consideration was given to structural measures in all watersheds as a means of flood damage reduction. Six watersheds (or portions thereof) were selected for intensive study based on their apparent possibility of achieving NED project action. Data developed from these six areas along with data from existing operational PL-566 watershed projects and cost estimates for other structural measures in the basin were used to evaluate the remaining watersheds for project action. The results of these investigations are summarized in Table VIII-1.

The sponsors expressed concern about sediment deposition in the Republican River and adjacent flood plain downstream from Harlan County Reservoir. A system of 22 possible structures on selected tributaries was investigated. These structures would provide flood damage reduction, reduce sediment yields to the Republican River, increase ground water recharge, and improve the cold-water fishery potential on Thompson and Center Creeks. The estimated installation cost of the 22 sites was $13.8 million.

It was determined that this system or any other of similar magnitude should not be implemented without detailed studies of possible effects that would occur. These studies should include monitoring of the existing Corps of Engineer's ranges on the Republican River as well as establishment and monitoring of additional cross-sections on the Republican and the major tributaries. During discussions with the sponsors, it was agreed that the proposed monitoring would be included in the EQ and Preferred Plan.

TABLE VIII-1 SUMMARY OF SMALL WATERSHED PROJECT POSSIBILITIES
Republican River Basin, Nebraska

Watershed Number	Watershed Name	Drainage Area (Acres)	Area Flooded 1/ (Percent)	Ave. Ann. Damage Per Ac. ($/Ac.)	Economic Justification	Remarks
41a-1	Chase Dundy Sandhills	123,900	.9	3	No	Large watershed - very low unit damages
41a-2	Indian Creek	100,000	1.0	19	"	Large watershed - low damages
41a-3	Burntwood Creek	67,200	.9	14	"	Total damages low and not concentrated - many tributaries
41a-4	Muddy Creek (Dundy Co.)	95,100	.9	23	"	Large drainage area above potential structures
41a-5	Culbertson to Stratton Tribs (N)	71,500	.7	21	"	Very low total damages
41a-6	Culbertson to Stratton Tribs (S)	90,300	.4	20	"	Very low total damages
41a-7	Driftwood Creek 5/	131,700	1.8	27	"	Special study - no alternatives justified
41a-8	Dry Creek (South) 6/	22,800	10.1	11	--	Structures installed
41a-9	McCook Tribs	45,200	3.3	15	No	Several tributaries - damages not concentrated
	Kelly Creek	7,400	1.4	9	"	Natural Resources District sponsored project is underway
41a-10	Sleepy Hollow, Brush, etc. Creeks	86,900	.9	27	"	Many tributaries - damages not concentrated
41a-11	Red Willow Creek (Upper)	272,000	.8	8	"	Low unit damage
41a-12	Red Willow Creek (Lower)	235,200	.8	16	"	Large drainage area above potential sites
41a-13	Coon Creek 5/	60,100	1.4	53	Yes	Special study - two structures in NEO Plan
41a-14	Dry Creek (Pilot) 6/	35,400	4.9	15	--	Structures installed
41a-15	Cambridge to Bartley Tribs (N)	30,400	1.0	30	No	Total damages low and not concentrated
41a-16	Silver Creek	30,100	.8	22	"	Very low total damage
41a-17	Republican River South Tribs (Furnas)	111,300	.6	23	"	Many tributaries - damages not concentrated
41a-18	Deer Creek	126,800	1.1	11	"	Long, large watershed - costs would be very high
41a-19	Muddy Creek (Frontier & Gosper)	161,100	1.2	16	"	Large watershed - large channel - low unit damage
41a-20	Elk-Turkey, etc., Creeks	205,800	1.4	21	"	Long, large drainage area - would require high structure costs
41a-21	Orleans Tribs	238,300	1.9	11	"	Many tributaries - low unit damage
	Milrose Creek 5/	11,700	6.9	37	Yes	Special study - proposed floodway in NEO Plan
41a-22	Turkey Creek 5/	106,200	2.2	30	No	Special study - no alternatives justified
41a-23	Lost Creek, etc., Tribs	54,100	1.1	24	"	Very low total damage
41a-24	Sacramento Tribs	76,700	4.0	3	"	Low damage total and unit value
41a-25	Center, etc., Tribs	99,100	1.3	22	"	Very high structure costs
41a-26	Thompson Creek	191,600	2.0	16	"	Low unit damage - high structure costs
41a-27	Lohff - Oak, etc., Creeks	84,800	1.9	18	"	Many tributaries - low unit damage
41a-28	Farmers, Indian, etc., Creeks	77,500	3.5	21	"	Low unit damage - high structure cost
41a-29	Red Cloud Tribs	95,800	1.4	31	"	Small area of damage - high structure cost
41a-30	Minnie Creek	6,500	1.5	67	"	Low unit damage
41a-31	Courtland Tribs	35,000	.7	36	"	Low total damage
41a-32	Superior Tribs	146,000	1.8	33	"	Many tributaries - damages not concentrated
41a1-8	North Fork Republican River 2/	14,600	1.4	4	"	Very low unit damage
41a1-10	Buffalo Creek	82,100	.2	10	"	Tiny damaged area
41a1-11	Rock-Spring Creeks 5/	180,200	.3	15	"	Large watershed - small damaged area
41a1-12	Hay Canyon, etc., Tribs	26,300	.8	13	"	Low unit damage
41a1(a)-8	Arikaree River 3/	8,300	0	--	--	No damages
41a2-13	South Fork Republican River 4/	3,900	0	--	--	No damages
41a3-1	Sand Creek	67,800	4.4	8	No	Low unit damage
41a3-4	Frenchman River (Enders Reservoir)	164,400	1.4	7	"	Very low unit damage
41a3-5	Frenchman River (Wauneta Tribs)	102,600	1.5	22	--	Special study by Nebraska Natural Resources Commission
41a3-6	Frenchman River (Lower)	131,400	3.9	14	No	Area for potential control too small
41a3-7,8	Blackwood Creek 6/	287,600	2.0	6	--	Work plan finished
41a3(a)-1	Venago Tribs	38,100	1.3	11	No	Low damage total
41a3(a)-2	Spring Creek (Upper)	113,300	.9	6	"	Low damage total
41a3(a)-3	Grant Tribs	147,400	.7	5	"	Low damage total
41a3(a)-4	Stinking Water Creek (Upper)	231,000	1.2	7	"	Large watershed - very low damage value
41a3(a)-5	Spring-Stinking Water Creeks (Lower)	148,600	3.4	10	"	Low unit damage value
41a4-1	Medicine Creek (Sandhills)	230,200	.7	1	--	No damages
41a4-2	Medicine Creek (Upper) 6/	219,100	1.2	10	--	Operational watershed
41a4-3	Medicine Creek (Lower) 6/	152,700	2.6	19	--	Operational watershed
41a4-4	Medicine Creek (Includes Mitchell Creek)	83,500	.4	5	--	Major structure installed
41a5-6	Sappa Creek	17,100	1.0	18	No	Most of watershed in Kansas - low damage total
41a5-7	Sappa Creek (Lower)	119,300	7.5	28	"	Most of watershed in Kansas
41a5-8	Stamford 6/	2,900	14.1	12	--	Structural measures installed
41a5(a)-6	Beaver Creek	14,300	0	--	--	Special study - no justifiable alternative
41a5(a)-7	Beaver Creek (Lebanon) 5/	125,600	6.3	32	--	Special study - no justifiable alternative
41a5(a)-8	Beaver Creek (Beaver City) 5/	129,400	7.1	31	--	Special study - no justifiable alternative
41a6-4	Prairie Dog Creek (Lower)	40,300	5.2	27	No	Damages not concentrated

Note: Price Base: Current Normalized Prices (July 1976) for agricultural damages, 1975 prices for other damages.
1/ Area needing project action is defined as flood plain adjacent to tributary stream courses inundated by the 100 yr. storm.
2/ D. A. in Nebraska Common flood plain affected by tributaries is 200 ac. (total flood plain area - Mainstem 2600 ac.)
3/ D. A. in Nebraska Common flood plain affected by tributaries is zero ac. (total flood plain area - Mainstem 1200 ac.)
4/ D. A. in Nebraska Common flood plain affected by tributaries is zero ac. (total flood plain area - Mainstem 750 ac.)
5/ Watersheds selected for intensive study.
6/ PL-566 Watersheds approved for installation of structural measures. Only remaining damages listed for these watersheds.

CHAPTER IX
THE PREFERRED PLAN

Introduction

The Preferred, National Economic Development and Environmental Quality Plans were progressively developed by the Republican Inter-Basin Council, sponsors of the Republican Basin Cooperative Study, Council Advisors, members of the USDA River Basin staff, and representatives of other agencies that cooperated with the study. Representatives of the sponsoring organizations and others constituted the membership of the task forces (TF) formed to handle various aspects of the study. These included the Fish and Wildlife and Recreation TF; Conservation, Soil Loss, Sediment, and Non-Point Pollution TF; Municipal, Industrial and Rural Water TF; Hydrology TF; Economics and Land Use TF; and the Plan Formulation TF. Each task force held three to five meetings during the study course. These periodic meetings were held by the task forces to review the data developed by the study and to discuss possible remedial actions. Five to fifteen people participated in each of those meetings. Their findings and recommendations were provided to the Plan Formulation TF on a continuous basis. The Republican Inter-Basin Council met twice yearly over a period of more than three years, and progress and findings were reported to them at these meetings. Discussions were held regarding possible solutions, and other guidance was provided by the council. Two public meetings were held to solicit needs and problems perceived by them and to review findings and alternative plans. The number of people attending these meetings varied from 20 to 50. See Chapter II for additional details.

The Preferred Plan presented here is a blending of the NED and EQ Plan elements to produce a combination that maximizes both the NED and EQ objectives to the greatest degree possible. In accordance with normal planning procedure, the NED and EQ Plans were scrutinized by the sponsors, element by element, to determine which of them should be selected for incorporation into the Preferred Plan.

The Preferred Plan includes nonstructural and structural measures and a basic assumption that the measures installed will be of a quality to endure over an extended period.

Fully implemented, the Preferred Plan would:

1. Reduce flood damages on 1,680 acres of cropland.

2. Create opportunities for an additional 42,200 hunter-days for pheasants and 1,000 hunter-days for quail.

3. Reduce erosion on 466,960 acres.

4. Reduce erosion along 150 miles of roads.

5. Protect and enhance 1,300 acres of wetlands.

6. Improve fishery in 60 miles of warm water streams.

7. Establish vegetation for wildlife habitat in critical source areas throughout basin.

8. Enhance 45,000 acres of existing canyon shrub habitat.

9. Establish 12,200 acres of wildlife habitat in center pivot corners.

10. Establish grasses, legumes, trees, and shrubs on 55,350 acres and renovate habitat on 21,650 acres.

11. Enhance irrigation reuse pits and adjacent lands (about 510 acres) for use by waterfowl and other wildlife.

12. Improve fishery on about 20 miles of cold water streams.

13. Protect about 6,700 acres of riparian woodlands.

14. Establish monitoring system of sediment deposition downstream from Harlan County Dam.

Display Accounts

Display tables follow which show the effects of the Plan, a summary of the effects, a comparison to other plans, and the capability of the alternative to satisfy needs.

NATIONAL ECONOMIC DEVELOPMENT PLAN

STUDY OBJECTIVE - Reduce flooding on cropland.

PLAN ELEMENT - Install two floodwater retarding structures in Coon Creek Watershed and 6,600 feet of floodway in Milrose Creek.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS	Average Annual
Total flood prevention benefits	$66,000
1. Agricultural benefits	51,500
2. Nonagricultural benefits	14,500

ADVERSE EFFECTS 1/	Total Cost	Average Annual Cost REGION	Average Annual Cost REST OF NATION
1. Structure installation cost	$412,000	-	$29,380
2. Landrights	150,000	$10,700	-
3. Engineering service and project administration	157,000	600	10,600
4. Operation, maintenance and replacement		3,000	
Subtotal	719,000	14,300	39,980
Total Adverse		$54,280	
Net Beneficial Effect		+$11,720	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Withhold 900 acre-feet of sediment.
2. Mitigate 7 acres of wildlife habitat.
3. Reduce sediment and scour damages.
4. Provide approximately 175 acres of grass and herbaceous wildlife cover on dams and in dry sediment pools.
5. During construction:
   a. Increase possible sediment deposition downstream.
   b. Increase dust and noise pollution.
   c. Increase fuel consumption.
   d. Disrupt wildlife population.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase vehicular traffic in construction vicinity.
2. Reduce flooding on 1,680 acres of cropland.
3. Can provide as many as 15 man-years of direct and indirect employment during construction period. 2/

1/ Total costs shown in line item amortized @ 6 7/8 percent for 50 years.
2/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Increase outdoor recreation opportunities.

PLAN ELEMENT - Improve game bird habitat and increase populations, thus, providing opportunities for an additional 42,200 hunter-days for pheasants and 1,000 hunter-days for quail.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS 1/	Average Annual
Hunter-day benefits	$129,600

ADVERSE EFFECTS 2/
Costs not determined

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase vehicular traffic in basin, thus, increasing noise and dust pollution.
2. Increase chance of disturbance to other game and nongame populations.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase opportunity for firearm related accidents and injury.
2. Increase opportunity for accidental fires.
3. Can provide as many as two man-years of direct and indirect employment per year.

1/ Benefits based on 43,200 hunter-days at $3.00 per day (42,200 hunter-days for pheasants and 1,000 hunter-days for quail). Installation of the EQ Plan will provide an estimated 14,100 additional hunter-day opportunities for quail.

2/ The actual costs for this plan element are indeterminable. The needs identified in Chapter VII for pheasant hunter-days will be partially met by installation of the Preferred Plan elements, and all projected needs for quail hunting will be easily satisfied. The Preferred Plan elements, which will provide most of the hunting opportunities, are Nos: 1, 3, 4, 5, 7, 8, 9, 10, 11, and 13 as listed on page IX-1 and 2.

PREFERRED PLAN

STUDY OBJECTIVE - Reduce water and wind erosion on 466,960 acres.

PLAN ELEMENT - Manage 79,280 acres of pasture and rangeland, install 14,056 miles of terrace, install 10,560 acres of waterways, change land use on 82,480 acres.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS

Accelerated land treatment not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Installation costs of land treatment	$6,506,000	$19,518,000
2. Technical assistance	-	4,889,000
Subtotal	6,506,000	24,407,000
Total Costs	$30,913,000	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Reduce erosion on 466,960 acres to less than 5 tons/acre/year.
2. Improve water quality in streams, rivers and reservoirs by reducing sediment concentrations.
3. Decrease agricultural nutrient contributions to streams, rivers and reservoirs.
4. Improve quality of aquatic ecosystems.
5. Enhance wildlife resources.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance visual quality of landscape.
2. Increase wildlife habitat and population for human recreation.
3. Improve water quality for all purposes.
4. Can provide as many as 536 man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Reduce erosion along 150 miles of road.

PLAN ELEMENT - Seed, mulch, stabilize and manage erosive roadside areas.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS	REGION	REST OF NATION
1. Total installation Costs	$135,000	$135,000
Total Installation Costs		$270,000

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality in streams.
2. Create roadside wildlife habitat.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase frequency of wildlife on roads.
2. Increase chance of vehicle-firearm accidents.
3. Enhance visual quality of roadsides.
4. Enhance fire hazard along roads.
5. Can provide as many as three man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Protect and enhance 1,300 acres of wetlands.

PLAN ELEMENT - Lease and fence wetlands.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Cost of Leases 1/	$390,000	$97,500
2. Technical Assistance	1,950	650
Subtotal	391,950	98,150

Total Installation Costs $490,100

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Preserve wetlands for wildlife habitat and waterfowl production.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Preserve wetlands for production of wildlife and waterfowl for human recreation.
2. Provide possibility of outdoor classrooms.
3. Enhance production of pest insects.

1/ Total value of 25-year leases.

PREFERRED PLAN

STUDY OBJECTIVE - Improve warm water fishery.

PLAN ELEMENT - Treat critical sediment sources; install fencing for livestock exclusion; establish woody and herbaceous bank plantings on 7 miles of Stinking Water Creek, on 20 miles of Upper Stinking Water and Spring Creeks, on 19 miles of Medicine Creek,and on 14 miles of Red Willow Creek. Investigate and encourage possible legislative action to establish minimum flows in streams.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total Installation costs	$71,100	-
2. Technical Assistance	7,500	$2,500

Total Installation Costs $81,100

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality for fish by reducing sedimentation.
2. Improve fish cover with bank vegetation.
3. Improve wildlife habitat on banks.
4. Increase sediment in streams during installation of bank plantings.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve visual quality of streambanks.
2. Improve fishery resource for human recreation.
3. Reduce landowner rights on treated streams.
4. Can provide as many as three man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Enhance wildlife habitat in critical source areas throughout basin.

PLAN ELEMENT - Treat critical areas by establishment of vegetation and fencing on 13,900 acres.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total Installation Costs	$2,224,000	$6,672,000
2. Technical Assistance	27,800	111,200
Subtotal	2,251,800	6,783,200
Total Installation Costs		$9,035,000
3. Reduced grazing production per year	$33,400	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Reduce wind and water erosion by establishment of vegetative cover protected by fencing.
2. Provide food supply and winter cover for wildlife.
3. Improve downstream water quality.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance visual quality of landscape.
2. Increase wildlife habitat and population for human recreation.
3. Can provide as many as 162 man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Enhance existing canyon shrub habitat.

PLAN ELEMENT - Lease 45,000 acres of shrub habitat, thus, protecting its wildlife value.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Cost of leases[1/]	$3,375,000	-
2. Technical assistance	72,000	$18,000
Subtotal	3,447,000	18,000
Total Installation Costs	$3,465,000	
3. Reduced grazing production per year	$162,000	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Provide food supply and winter cover for wildlife.
2. Improve habitat for non-game species.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve hunting by decreasing winter mortality losses.
2. Decrease livestock grazing.
3. Can provide as many as two man-years of direct and indirect employment during construction period.[2/]

1/ Total value of ten-year leases.
2/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Utilize center pivot corners for wildlife habitat.

PLAN ELEMENT - Establish 12,200 acres of wildlife habitat in center pivot corners.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total cost of seeding and fencing	$610,000	$1,830,000
2. Technical assistance	12,200	12,200
Subtotal	622,200	1,842,000
Total Installation Costs		$2,464,400
3. Reduced crop and grazing production per year	$988,200	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Decrease energy consumption by reducing vegetative maintenance.
2. Create 12,200 acres wildlife habitat.
3. Reduce wind and water erosion.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase wildlife habitat and population for human recreation.
2. Increase fire hazard.
3. Improve vehicle driver visibility by reducing wind erosion.
4. Can reduce employment as much as 33 man-years annually due to decreased agricultural production.
5. Can provide as many as 45 man-years of direct and indirect employment during period of renovation. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Protect, create, manage and improve wildlife habitat throughout basin.

PLAN ELEMENT - Establish grasses, legumes, trees and shrubs on about 55,350 acres. Improve and renovate habitat on about 21,650 acres.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Establish new habitat	$3,736,000	$11,208,000
2. Renovate existing habitat	1,083,000	3,247,000
3. Technical assistance	30,800	123,200
Subtotal	4,849,800	14,578,200
Total Installation Costs	$19,428,000	
4. Reduced grazing production per year	$78,000	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality by reducing sediment movement.
2. Improve quality of wildlife habitat.
3. Increase food supply and winter cover for wildlife.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase wildlife population for human recreation.
2. Change visual appearance of landscape.
3. Can provide as many as 380 man-years of direct and indirect employment during construction period. 1/
4. Can reduce employment as much as three man-years annually due to decreased agricultural production.

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Increase value of irrigation re-use pits for waterfowl and other wildlife.

PLAN ELEMENT - Establish grasses; stabilize banks; manage water levels; install fencing on about 510 acres of irrigation re-use pits and adjacent lands.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Total installation costs	$25,500	$76,500
2. Technical assistance	255	765
Subtotal	25,755	77,265
Total Installation Costs		$103,020

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance use of pits by waterfowl for nesting and resting.
2. Establish wildlife habitat.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Enhance visual quality of re-use pits.
2. Limit livestock use of pits.

PREFERRED PLAN

STUDY OBJECTIVE - Improve cold water fishery in Rock Creek, Buffalo Creek, Elm Creek and Thompson Creek.

PLAN ELEMENT - Install fencing and streambank protection to 20 miles of streams; install instream mechanical practices on 20 miles of stream; remove old dam on Rock Creek.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Install streambank protection and instream practices	$33,300	-
2. Remove old dam on Rock Creek	15,000	-
3. Technical assistance	6,500	$4,500
Subtotal	54,800	4,500
Total Costs	$59,300	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Improve water quality by reducing sedimentation.
2. Improve fish cover with bank vegetation.
3. Improve wildlife habitat on banks.
4. Create spawning areas for trout.
5. Decrease water quality during short term installation of practices.
6. Reduce water temperature in Rock Creek stream and lake.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase fish population for human recreation.
2. Improve visual quality of streambanks.
3. Reduce landowner rights on treated streams.
4. Can provide as many as two man-years of direct and indirect employment during construction period. 1/

1/ Employment effects are not limited to local workers. Contractors may employ workers and purchase equipment and supplies outside of the basin as well as locally.

PREFERRED PLAN

STUDY OBJECTIVE - Preserve and protect riparian woodland.

PLAN ELEMENT - Lease 36,700 acres of riparian woodlands.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS

	REGION	REST OF NATION
1. Cost of leases[1/]	$9,175,000	-
Total	$9,175,000	
2. Reduced grazing production per year.	$ 264,200	

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

1. Increase wildlife habitat value of woodlands.
2. Improve growth and vigor of remaining forest land.

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECT

1. Improve visual quality of forest land.
2. Reduce landowner use of woodlands.

1/ Twenty-five year lease.

PREFERRED PLAN

STUDY OBJECTIVE - Establish monitoring system of sediment deposition downstream from Harlan County Dam.

PLAN ELEMENT - Establish additional degradation ranges on Republican River and on major tributaries to determine sediment disposition. Study possible effects of large structural system on sediment deposition, fishery resource, wildlife habitat, flood damage reduction and social acceptance.

ECONOMIC DEVELOPMENT ACCOUNT

BENEFICIAL EFFECTS
Not evaluated in monetary terms.

ADVERSE EFFECTS
Not evaluated.

ENVIRONMENTAL QUALITY ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

None

SOCIAL WELL-BEING ACCOUNT
BENEFICIAL AND ADVERSE EFFECTS

None

TABLE IX-1 SUMMARY OF PLANNING EFFECTS - PREFERRED PLAN
Republican River Basin, Nebraska

Account	Unit	Preferred Plan
A. ECONOMIC DEVELOPMENT		
1. Plan elements evaluated for benefits and costs		
a. Beneficial effects	Av. Ann. Dollars	66,000
b. Adverse effects	"	54,280
c. Net beneficial effects	"	11,720
2. Plan elements evaluated for benefits only		
a. Beneficial effects	Av. Ann. Dollars	129,600
b. Adverse effects - not evaluated in monetary terms		
3. Plan elements evaluated for costs only		
a. Beneficial effects - not evaluated in monetary terms		
b. Adverse effects - total installation and technical assistance cost	Dollars	67,983,920
1. Reduced annual crop and grazing production	Av. Ann. Dollars	1,309,840
B. ENVIRONMENTAL QUALITY (Beneficial and adverse effects)		
1. Quality consideration of water, land and air resources		
a. Reduce erosion to less than tolerable limits.	Acres	467,000
b. Improve water quality in streams and reservoirs by reducing sediment delivery.	Yes or No	Yes
c. Decrease agricultural nutrient contributions to streams and reservoirs.	"	"
d. Preserve wetlands.	Acres	1,300
e. Reduce water temperature in Rock Creek lake and stream.	Yes or No	Yes
f. Increase sedimentation during short term installation of structural measures.	"	"
g. Increase fire hazard along roads.	Miles	150
2. Areas of natural beauty		
a. Enhance visual quality of stream corridors.	Miles	80
b. Change visual quality of landscape with installation of land treatment measures and habitat plantings.	Acres	467,000
c. Increase noise and dust pollution during hunting seasons	Yes or No	Yes
3. Biological resources and selected ecosystems		
a. Improve conditions for waterfowl and other wildlife by preserving wetlands.	Acres	1,300
b. Improve quality of aquatic ecosystems.	Yes or No	Yes
c. Improve cover for fish in streams.	Miles	80
d. Improve wildlife habitat in riparian woodlands.	Acres	6,700
e. Improve fish habitat in streams.	Miles	20
f. Enhance wildlife habitat in critical source areas in basin.	Yes or No	Yes
g. Increase chance of water pollution by sediment during installation of structural measures.	"	"
h. Establish habitat for wildlife in center pivot corners.	Acres	12,200
i. Enhance waterfowl conditions with management of irrigation reuse pits.	"	510
j. Disturb wildlife populations during construction.	Yes or No	Yes
4. Irreversible or irretrievable commitment of resources		
a. Change cropland, pastureland and rangeland to dams, emergency spillways, sediment pools and floodways.	Acres	170
b. Commit fuel consumption during installation of structural measures.	Yes or No	Yes

(Continued)

TABLE IX-1 (Continued)

Account	Unit	Preferred Plan
C. SOCIAL WELL-BEING (Beneficial and adverse effects)		
1. Provide potential employment during construction period.	Man-Years	1,148
2. Enhance visual quality of agricultural landscape.	Acres	467,000
3. Increase hunting opportunities.	Yes or No	Yes
4. Increase fishing opportunities.	"	"
5. Enhance visual quality of stream corridors.	Miles	80
6. Increase population of fish and wildlife for added human enjoyment.	Yes or No	Yes
7. Provide resource for development of outdoor classrooms.	"	"
8. Enhance visual quality of land and water in local areas.	"	"
9. Improve production of non-game wildlife species used for recreation.	"	"
10. Decrease landowner control of leased areas.	"	"
11. Increase frequency of wildlife on roads and railroads.	"	"
12. Increase safety hazard from increase in firearm use.	"	"
13. Continue and enhance production of insect pests on 1,300 acres of wetland.	"	"
14. Provide potential for additional employment per year.	Man-Years	2
15. Create potential for reduction in existing employment per year.	"	36

TABLE IX-2 SUMMARY COMPARISON OF ALTERNATIVE PLANS
Republican River Basin, Nebraska

Accounts	Unit of Measure	NED Plan	EQ Plan	Preferred Plan
A. ECONOMIC DEVELOPMENT				
1. Plan elements evaluated for benefits and costs				
a. Beneficial effects	Av. Ann. Dollars	66,000	--	66,000
b. Adverse effects	Av. Ann. Dollars	54,280	--	54,280
c. Net beneficial effects	Av. Ann. Dollars	11,720	--	11,720
2. Plan elements evaluated for benefits only				
a. Beneficial effects	Av. Ann. Dollars	129,600	--	129,600
b. Adverse effects - not evaluated in monetary terms.				
3. Plan elements evaluated for costs only				
a. Beneficial effects - not evaluated in monetary terms.				
b. Adverse effects (total installation plus technical assistance cost).	Dollars	--	86,607,420	67,983,920
1. Reduced annual crop and grazing production.	Av. Ann. Dollars	--	1,707,800	1,309,800
B. ENVIRONMENTAL QUALITY (Beneficial & adverse effects)				
1. Areas of natural beauty				
a. Enhance visual quality of stream corridors.	Miles	--	80	80
b. Change visual quality of landscape with installation of land treatment measure and habitat plantings.	Acres	--	583,700	467,000
c. Increase noise and dust pollution during hunting seasons.	Yes or No	--	Yes	Yes
2. Quality consideration of water, land and air resources.				
a. Reduce erosion to less than tolerable limits.	Acres	--	583,700	467,000
b. Improve water quality in streams and reservoirs by reducing sediment concentration.	Yes or No	Yes	Yes	Yes
c. Decrease agricultural nutrient contributions to streams and reservoirs.	Yes or No	Yes	Yes	Yes
d. Increase sedimentations during short term installation of structural measures.	Yes or No	Yes	Yes	Yes
e. Increase fire hazard along roads.	Miles	--	150	150
f. Preserve wetlands.	Acres	--	1,300	1,300
g. Reduce water temperature in Rock Creek lake and stream.	Yes or No	No	Yes	Yes
3. Biological resources and selected ecosystems				
a. Improve conditions for waterfowl and other wildlife by preserving wetlands.	Acres	--	1,300	1,300
b. Improve quality of aquatic ecosystems.	Yes or No	Yes	Yes	Yes
c. Improve cover for fish in streams.	Miles	--	80	80
d. Improve wildlife habitat in riparian woodlands.	Acres	--	36,700	6,700
e. Enhance fish habitat in streams.	Miles	--	20	20
f. Enhance wildlife habitat in critical source areas. throughout basin.	Yes or No	No	Yes	Yes
g. Increase chance of water pollution by sediment during installation of structural measures.	Yes or No	Yes	Yes	Yes
h. Increase wildlife habitat population in center pivot areas by establishment of vegetation in corners.	Acres	--	12,200	12,200
i. Disturb wildlife populations during construction.	Yes or No	Yes	Yes	Yes
j. Enhance waterfowl conditions with management of irrigation reuse pits.	Acres	--	510	510
4. Irreversible or irretrievable commitment of resources				
a. Change cropland, pastureland and rangeland to dams, emergency spillways, sediment pools and floodways.	Acres	170	--	170
b. Commit fuel consumption during installation of structural measures.	Yes or No	Yes	Yes	Yes
C. SOCIAL WELL-BEING (Beneficial & adverse effects)				
1. Provide potential for employment during construction period.	Man-Years	15	1,311	1,148
2. Enhance visual quality of agricultural landscape.	Acres	--	583,700	467,000
3. Increase hunting opportunities.	Yes or No	Yes	Yes	Yes
4. Decrease landowner control of leased areas.	Yes or No	No	Yes	Yes
5. Increase fishing opportunities.	Yes or No	No	Yes	Yes
6. Enhance visual quality of stream corridors.	Miles	--	80	80
7. Increase frequency of wildlife being on roads and railroads.	Yes or No	No	Yes	Yes
8. Increase population of fish and wildlife for added human enjoyment.	Yes or No	No	Yes	Yes
9. Provide resource for development of outdoor classroom.	Yes or No	No	Yes	Yes
10. Increase safety hazard from increase in firearm use.	Yes or No	No	Yes	Yes
11. Enhance visual quality of land and water in local areas.	Yes or No	Yes	Yes	Yes
12. Improve production of non-game wildlife species used for recreation.	Yes or No	No	Yes	Yes
13. Continue and enhance pest insect production on 1,300 acres of wetlands.	Yes or No	No	Yes	Yes
14. Provide potential for additional employment per year.	Man-Years	2	--	2
15. Provide potential for reduction of existing employment per year.	Man-Years	--	45	36

TABLE IX-3 CAPABILITY OF ALTERNATIVE PLANS TO SATISFY NEEDS - YEAR 2000
Republican River Basin, Nebraska

Study Objective	Unit of Measure	Quantity	NED Plan Needs Satisfied	NED Plan Needs Remaining	Preferred Plan Needs Satisfied	Preferred Plan Needs Remaining	EQ Plan Needs Satisfied	EQ Plan Needs Remaining
Increase hunting opportunities								
a. Quail	Man-Days	1,000	1,000	0	1,000	0	0	0
b. Pheasants	Man-Days	86,000	43,200	42,800	43,200	42,800	0	0
Reduce flood damages	Dollars	2,955,800	66,000	2,889,800	66,000	2,889,000	0	2,749,000
Reduce erosion on cropland, pastureland and rangeland	Acres	584,000	0	0	467,000	117,000	584,000	0
Reduce roadside erosion	Miles	150	0	150	150	0	150	0
Improve warm water fishery	Miles	60	0	60	60	0	60	0
Improve cold water fishery	Miles	20	0	20	20	0	20	0
Create and improve wildlife habitat	Acres	148,000	0	148,000	148,000	0	148,000	0
Protect wetlands	Acres	1,300	0	1,300	1,300	0	1,300	0
Protect riparian woodlands	Acres	36,700	0	36,700	6,700	30,000	36,700	0
Improve irrigation reuse pits for wildlife and waterfowl	Acres	510	0	510	510	0	510	0

CHAPTER X
OPPORTUNITIES FOR IMPLEMENTING PLAN ELEMENTS UNDER USDA PROGRAMS AND PROGRAMS OF OTHER AGENCIES

Chapter IX presented the Preferred Early Action Plan to be accomplished by 2000 which included economic development elements and environmental quality enhancement elements. This chapter presents the USDA programs and programs of other agencies that are available to help accomplish those plan elements and evaluates the probable impacts of their implementation. A discussion of most current agency programs in the basin is in Chapter III. Additional commentary is presented here regarding State, County, NRD, and other local programs.

Local Programs to Implement the Plan

Counties, in cooperation with municipalities, councils of governments, and State agencies must take the leadership in land use planning and implementation of land use regulations where they are needed. Zoning and other regulations are necessary in certain areas to protect property owners from suffering floodwater losses and for more orderly development of their resources. Often certain regulations are required before an area is eligible for flood insurance. Flood hazard information may be furnished through programs of the U.S. Department of Housing and Urban Development.

Plans will need to be made by communities to combat the problem of pollution. Improved land treatment and use will help reduce non-point pollution. Improvements are in order in the disposal of solid waste. Location of sites for solid waste disposal by communities must be followed through to completion.

The County roads departments will provide a major share of the roadside erosion control program. Landowners and operators will provide their share of the cost of treatment of gullies and other erosion. Counties and municipalities must cooperate with developers and others in treating construction sites to prevent sediment damages downstream.

Cities, towns and rural communities must make long range plans to meet their water needs. They must agree on the location of future development and work out methods of financing. Councils of government will provide important planning assistance to these areas. Grants and loans may be available from other Federal agencies.

Towns and cities usually have the legal power to raise funds, acquire land and provide the necessary leadership needed to install their needed facilities. Rural areas that need waste water treatment facilities often need to organize into public service districts or some other legal organization before they can borrow funds and install their needed facilities. Federal agencies, such as the Department of Housing and

Urban Development might have funds available for assisting towns and cities in financing and planning their installations.

The Nebraska Natural Resources Districts (NRD's) have an array of project authorities available to local people on solving local resource problems. These authorities related to soil and water resources include: (1) erosion prevention and control; (2) prevention of damages from flood-water and sediment; (3) flood prevention and control; (4) soil conservation; (5) water supply for any beneficial use; (6) development, management, utilization, and conservation of ground water and surface water; (7) pollution control; (8) solid waste disposal and sanitary drainage; (9) drainage improvement and channel rectification; (10) development and management of fish and wildlife habitat; (11) development and management of recreational and park facilities; and (12) forestry and range management.

An NRD may be authorized to conduct demonstration projects on land which it owns, or that owned by cooperators, or by consenting State agencies. It may also provide financial assistance to landowners seeking conservation measures for their land, and, within legislative guidelines, adopt regulations for resource management making various conservation measures or practices mandatory.

USDA programs are planned to furnish accelerated technical assistance for installing land treatment practices and for conservation planning assistance. Some funds are planned for cost-sharing assistance. This leaves the job of decision making and installation to landowners or operators. To accomplish the plans for land treatment, farmers must make land use adjustments and finance changes in land use. An education program is an essential element in accomplishing desired changes.

Individual landowners and operators and other land holding groups are expected to provide important contributions to protection of resources, especially wildlife and other values associated with forest land.

State Programs

The Wildlife Habitat Program, LB #861, was passed by the Nebraska Legislature in 1976 and provides an innovative vehicle by which the Nebraska Game and Parks Commission can progress toward its stated goals and objectives. New funds generated by license increases and issuance of the Habitat Stamp will be used in several programs within the following broad framework:

A. Private lands habitat program

I. Establishing permanent cover for wildlife
II. Protection of existing wildlife cover

III. Sweet clover plantings with oats
IV. Special practice, serving special needs of a local area

B. Wildlife management on public lands

C. Wildlife land acquisition

Monies will be budgeted for annual habitat development or preservation. This yearly allocation should provide various types of habitat on some 63,000 acres statewide through contracts with landowners, via the NRD. All practices in the private lands program will also provide for soil and water conservation, a dual benefit. Based on a cost-share concept, the private lands program is funded 75% by the Game and Parks Commission monies, which are matched by 25% NRD funds.

Habitat improvement on public lands, either owned or controlled by various government agencies and political sub-divisions, are involved in this program. Considerable opportunity exists for improving cover on Game Commission lands or other lands, whether it be planting and caring for trees and shrubs, seeding grasses and legumes, or planting standard crops for food and cover. Much can be done to enhance many areas for the secondary benefit of wildlife habitat. A prime example of public funds well spent is the County roadside seeding program. Resources will be available each year to fund this public lands program.

The Wildlife Land Acquisition Program will provide funds for purchase of prime wildlife lands. The Commission has placed its highest priority on the acquisition of wetlands in the rainwater basins (a portion of these is found within the basin) of south-central Nebraska. Other wetlands, riparian land and water areas also have a high priority for acquisition.

The Nebraska State Health Department has been and will continue to be active in vector control programs in the basin.

Specific Programs for Implementation of Preferred Plan

Listed below are programs or needed changes in present laws in order to implement the Preferred Plan:

1. Reduce cropland floodings; SCS, PL 83-566; NRD's, landrights acquisition.

2. Conservation Land Treatment

   Natural Resources Districts - Technical assistance and cost-sharing.

   Soil Conservation Service - Technical assistance and Great Plains Conservation Program cost-sharing.

Agriculture Stabilization and Conservation Service - Cost-sharing program on conservation measures.

Environmental Protection Agency - Cost-sharing for reduction of water pollution through 208 Program.

Nebraska State Forester - (Cooperating with U.S. Forest Service) technical advice and services in the procurement and planting of trees and shrubs.

3. Roadside Erosion - The counties will increase their cooperation with the Nebraska Game and Parks Commission in their wildlife roadside management program. The 208 Water Quality Program will also furnish data and programs that will provide funds for control of roadside erosion.

4. Wetlands

   Water Bank (USDA) - Technical assistance and cost-sharing.

   Natural Resources Districts - Technical assistance and cost-sharing.

   Soil Conservation Service - Technical assistance.

   Game and Parks Commission - Wildlife habitat programs (leases and/or acquisition).

5. Stream Fisheries Improvements - Technical assistance from the NRD's and SCS, financial assistance through the NRD's and LB-861, and legislative action to provide for sufficient flows in streams with fisheries.

6. Upland Wildlife Habitat Management, Improvement, Creation, and Preservation; SCS Great Plains Program, ACP, NRD's, and LB-861, financial cost-share assistance programs.

7. Irrigation Reuse Pits - All of the needed treatment can be accomplished through conservation planning and application-needed financial cost-sharing programs (Great Plains or ACP). Technical assistance from SCS and NRD's.

8. Monitoring sediment deposition on lower Republican River. Technical assistance from SCS. Establishment by NRD's.

Combined Effects of USDA Programs Portion of the Plan

USDA programs will have some influence in the implementation of all plan elements. As can be seen in Table IX-1 and in the programs section

of this chapter, the influence of USDA programs varies from technical advice to substantial monetary inputs for the several plan elements. A summary of effects that would result from implementation of USDA portions of the plan is as follows.

Economic Development Impacts

Total adverse effect (USDA Program total cost) = $48,514,000
Beneficial effect - not all evaluated in monetary terms.

Environmental Impacts

1. Areas of Natural Beauty: The installation of those plan elements listed for enhancement of fisheries will also improve the visual qualities of stream corridors in the areas treated. The visual quality of the agricultural landscape will change with installations of land treatment measures, and in local areas, it will change as a result of installation and renovation of wildlife habitat.

2. Quality of Land, Water and Air: The accelerated land treatment program, when implemented, will reduce soil erosion. Treatment of cropland will result in a reduction of sheet erosion which will prolong the usefulness of the land resources. Also, there is a direct relationship between soil erosion and sediment delivered to streams; as erosion is reduced, sediment problems generally are also reduced. Treatment of critically eroding areas will help prevent the loss of soil from gullied areas, roadsides and streambeds, thereby reducing sediment deliveries to streams in the basin. The land treatment program along with critical area treatment will result in a reduction of sediment accumulations in the water courses throughout the basin. A major effect will be a reduction of sediment to five large reservoirs in the basin. The reduction of sediment in these areas will have a significant impact on improvement of water quality, channel capacity and structure life. Treatment of rangeland and pastureland will help improve ground cover which will improve infiltration of water into the soil, thereby reducing runoff and decreasing soil erosion. Treatment and protection of riparian forests will have a small effect in reducing streambank erosion.

3. Biological Resources and Selected Ecosystems: Treatment practices on cropland such as field borders, windbreaks and seeding of road rights-of-way will create habitat for pheasants, quail and other wildlife species. Removal of windbreaks and hedgerows for more efficient use of equipment will reduce wildlife habitat.

Improved grasses and management of pastures and rangelands will tend to improve wildlife food and cover. Treatment of critical areas, preservation and management of canyon-shrub habitat, planting center pivot corners to permanent wildlife cover, and planting numerous other areas to wildlife habitat will increase wildlife populations of all kinds throughout the basin.

Preservation and management of high value wetlands will provide much needed habitat for waterfowl and other aquatic birds and mammals. Seeding the areas adjacent to irrigation reuse pits to grasses and legumes will provide nesting cover for waterfowl. After the seasons last irrigation, water should be left in these pits to provide water for migrating waterfowl and terrestrial wildlife.

Treatment and management practices along warm water and cold water streams in the basin will improve water quality, reduce erosion, improve fish habitat, and increase fish production. Preserving riparian woodlands from conversion to other land uses will help prevent total changes in habitat types and disruption of wildlife populations.

Favorable Environmental Effects

1. Flooding will be reduced on 1,680 acres of cropland.
2. Soil erosion from agricultural lands will be reduced by 10.7 million tons annually or 35 percent.
3. Treat critical eroding gullies and headcuts on 13,900 acres.
4. Reduce sediment accumulating in the five major reservoirs in the basin by 917 thousand tons annually or 29 percent.
5. Improve water quality by reducing nutrient concentration in streams and reservoirs.
6. Reduce erosion and sedimentation along 80 miles of warm and cold water streams.
7. Preserve 1,300 acres of wetlands for wildlife habitat.
8. Water temperatures will be reduced along 20 miles of cold water streams with the establishment of woody and herbaceous streambank vegetation.
9. Reduce consumption of nonrenewable energy resources by reduced maintenance and tillage practices on road rights-of-way and marginal cropland by the establishment of permanent vegetative cover.

10. Increase the quality of the land for terrestrial wildlife on 161,800 acres. Plant over 81,000 acres to wildlife habitat.

11. Preserve 45,000 acres of canyon-shrub lands for upland wildlife habitat.

12. Preserve 6,700 acres of riparian woodlands.

13. Seed 510 acres of irrigation reuse pit sideslopes and adjacent lands for wildlife cover and erosion control.

Adverse Impacts Which Cannot Be Avoided

1. During installation of planned structural measures, local populations of fish and wildlife will be disturbed.

2. During construction, noise and dust pollution will be increased.

3. Eliminate 7 acres of wildlife habitat during installation of floodwater retarding structures.

4. Convert 175 acres of cropland, rangeland and pastureland to dams, emergency spillways, sediment pools, and floodways.

5. Increase fuel consumption during installation of plan elements.

6. Production of pest insects will be maintained or increased by preservation of wetlands.

7. Frequency of wildlife on roads will be increased.

Alternatives

One alternative to the elements of the Preferred Plan would be a "future without action". Present trends would continue in the basin, including encroachment on wildlife habitat and degradation of water quality.

Chapter VIII discusses alternatives to the Preferred Plan. The National Economic Development Alternative has been incorporated into the Preferred Plan except for lesser goals in land treatment. All of the elements of the EQ Plan are in the Preferred Plan with the following exceptions: (a) lesser goals in land treatment; (b) lesser value of acres of riparian woodland protected; and (c) elimination of four dams on Thompson Creek to improve the cold water fishery.

Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance of Long-Term Productivity

The Preferred Plan will contribute to the continued use of agricultural lands and the maintenance and improvement of the productive capacity of lands in the basin. Land treatment measures will permit continued use of the land to serve the present generation while preserving it for use by future generations. Farmers will have a wider selection of crops and cropping patterns from which to choose.

Measures for the protection and enhancement of fish and wildlife will have a sustaining positive impact in both short-term and long-term use of the environmental resource.

Irreversible or Irretrievable Commitment of Resources

1. About 175 acres of cropland, pastureland and rangeland will become dams, emergency spillways, sediment pools, and floodways.

2. Fuel consumed during installation of structural measures.

Projects Which Need Further Coordination With Other Agencies

The USDI, Bureau of Reclamation, is conducting a five-year study entitled, "Total Water Management, Republican River Basin" in Colorado, Kansas and Nebraska. The purpose of this study is to analyze the present surface irrigation demands in relation to declining base flows and runoff and develop alternative solutions to provide irrigation water at or about the rate supplied currently. The SCS will cooperate with the Bureau of Reclamation by supplying data to and assist in studying the effects of current and projected land treatment and its effect on surface water runoff from small watersheds.

As part of their post-construction monitoring procedures, the Corps of Engineers established a series of fourteen cross-section ranges on the Republican River from just below Harlan County Dam down to Superior, Nebraska. They were monitored by the Corps periodically through 1962, and a number of them were resurveyed in 1972. In 1976, the SCS located eight downstream ranges, surveyed the cross-sections and then compared the results of all the surveys. The SCS and the local NRD in cooperation with the Corps of Engineers will establish some additional ranges and assist in conducting future monitoring of them.

The U.S. Congress in October, 1972, passed the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). This act sets two goals: (1) to achieve wherever possible by July 1, 1983, water that is clean enough for swimming and other recreational uses and clean enough

for the protection and propagation of fish, shellfish and wildlife, and (2) to eliminate by 1985 the discharge of pollutants into the nation's waters.

These goals and the process to achieve them are the focus of water quality management. The amendments require programs to eliminate all pollution regardless of the source; to study alternative treatment methods; and to encourage consideration of advanced waste management techniques.

Planning under this Act is being carried out by the Nebraska Natural Resources Commission and implementation of the plan is the responsibility of the Nebraska Department of Environmental Control, the State pollution control agency. Regulatory actions and administrative procedures are to be used in meeting the objectives of the Act.

This plan will be useful to the Nebraska Department of Environmental Control in identifying areas of high sediment production. The SCS will furnish additional data and interpretations as available.